ELECTRICAL ENGINEERING

MARCH
1954

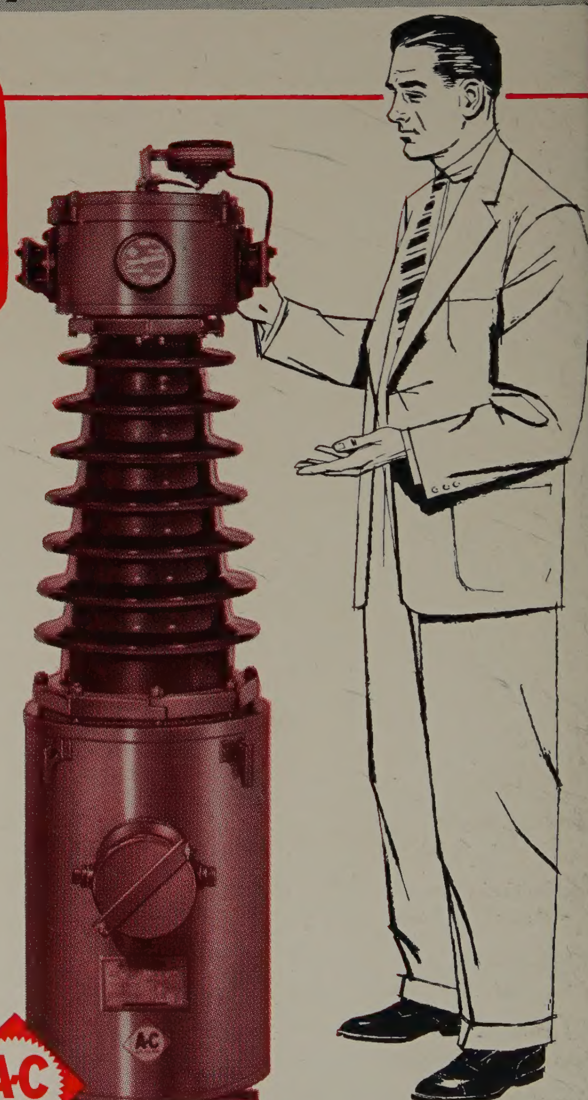
PUBLISHED MONTHLY BY THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

New Outdoor Current Transformer
IS LIGHTER, TAKES LESS SPACE

COMPARE THESE FIGURES

KV	DESIGN	FLOOR SPACE	HEIGHT	GAL. OIL	WEIGHT (lbs.)
25	New Type SCW	14″ x 19″	42″	9	230
	Previous Type	22″ x 22″	33″	15	490
34.5	New Type SCW	14″ x 19″	45″	9½	230
	Previous Type	22″ x 22″	33″	15	490
46	New Type SCW	16″ x 23″	55″	16	475
	Previous Type	23″ x 23″	40½″	18½	500
69	New Type SCW	16″ x 23″	61″	18	525
	Previous Type	28½″ x 28½″	46½″	35	1000

ALLIS-CHALMERS INSTRUMENT TRANSFORMERS



Here is a completely new line of current transformers for outdoor use on power circuits 69 kv and below. They bring you many new design features that result in excellent performance, high thermal and mechanical strength, plus mechanical advantages that simplify installation.

Most important, their ruggedness has been proved by exhaustive tests. Temperature rise at normal current is low, allowing ample overcurrent in emergencies. The transformers are rated 65 times normal primary current under short circuit conditions. Corona-free design extends insulation life.

For the complete story get your copy of the paper "Progress in Instrument Transformer Design" by writing Allis-Chalmers, Milwaukee 1, Wisconsin. A-4110

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ELECTRICAL ENGINEERING

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MARCH 1954

The Cover: Laboratory technician makes quick electronic count of human blood cells or other small particles with the system known as the Sanguinometer which is described on pages 288–9.

Statements and opinions given in articles appearing in *ELECTRICAL ENGINEERING* are expressions of contributors, for which the Institute assumes no responsibility. Correspondence is invited on controversial matters. Published monthly by the

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H. H. HENLINE, Secretary

VOL. 73 NO. 3

HIGHLIGHTS........

Presidential Address. There are many questions of great importance to the engineering profession today, but for his presidential address at the Winter Meeting Mr. Robertson chose for discussion one of the less glamorous but nevertheless vitally important Institute activities—its technical program (*pages 197–8*).

Management Development Program. Although this article does not recommend any specific course of action for management development, it presents as a case example the approach which was developed in the author's company, and which, in most cases, is proving to be quite practical (*pages 199–202*).

Edison Medalist for 1953. At this year's Winter General Meeting the Edison Medal for 1953 was presented to John Findley Peters of the Westinghouse Electric Corporation. A brief history of the medal was given by Chairman J. F. Fairman of the Edison Medal Committee (*page 215*), the medalist's career was outlined by his colleague, A. C. Monteith (*pages 215–17*), and Mr. Peters discussed the obligations of an engineer to his juniors, one of the bases upon which his award was made (*page 217*).

Radar Antenna Torque Requirements. After describing the equipment and tests conducted, the general results of the two groups of tests are discussed as well as the specific conclusions reached. They are offered to add to the fund of experience for future design work (*pages 262–4*).

News Index

50th Anniversary of the Cross-Field Dynamo. The inventor reviews the history of his invention and the subsequent inventions by himself and others. He includes with the combination of exciter and main dynamo, the cross-field dynamo, Woodbridge train lighting system for constant voltage, regulating pole cross-field generators, Pestarini's metadyne, and the amplidyne (*pages 203–08*).

Monoscope Tube for Computer and Other Applications. The monoscope tube, the monoscope requirements, the tube assembly, the circuit, and the *K1043* monoscope-tube tester are discussed together with other applications of the tube (*pages 208–12*).

Flexible High-Power Laboratory Capacitor Bank for Variety of Switching Tests Up to 65,000 Kvar. This new large capacitor bank has expanded considerably both the voltage and current range of capacitor switching tests (*pages 225–9*).

Electron Tube Performance in Some Typical Military Environments. Electronic tube reliability is being studied for the military services by collecting and analyzing tubes removed from equipments in field use. Interesting comparative data are presented on the causes of tube failure or removal in two different environments: a land-based fixed communications system and ship-borne equipments (*pages 233–8*).

Electrical Insulation and International Standardization. Developing more accurately evaluative standards for electrical insulation especially with regard to temperature limitations is the concern of these three short articles. An account of the efforts of groups in the United States as well as those of the International Electrotechnical Commission is presented. The principles for establishing temperature classification of insulating materials by functional test are given (*pages 240–6*).

A Simplified Unit for Distance Relaying. The use of high-speed distance relays for protecting the longer moderate- to high-voltage lines is a generally accepted practice. A simplified unit has been developed which is described (*pages 249–50*).

Cathode-Ray-Tube Protractor or Synchroscope. The phase difference between two voltages is displayed as a simple straight line on a cathode-ray tube. If the frequencies of the two voltages differ slightly the line will rotate on the screen. When the phase difference changes by 360° the line rotates through an angle of 180°. The circuit requires only 12 resistors and four capacitors and all angles from zero through 360° can be read on a standard cathode-ray tube (*pages 220–1*).

Microwaves for Observation of Commutator and Slip Ring Surfaces During Operation. This method of utilizing short-wave radio and waveguide components to observe and record surface irregularities in commutators and slip rings while the associated machinery is operating is discussed in terms of its principle of operation, the effect of parameters, practical operating data, and the results of tests on operating machines (*pages 251–5*).

Equipment Grounding for Industrial Plants. Adequate equipment grounding is shown to be one of the most important factors in safety to personnel in industrial plants by an analysis of accident data. It therefore is examined on the basis of its various components (*pages 256–60*).

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. The publications also are available to Student members at the annual subscription rate of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. H. H. Henline, Secretary, 33 West 39th Street, New York 18, N. Y.

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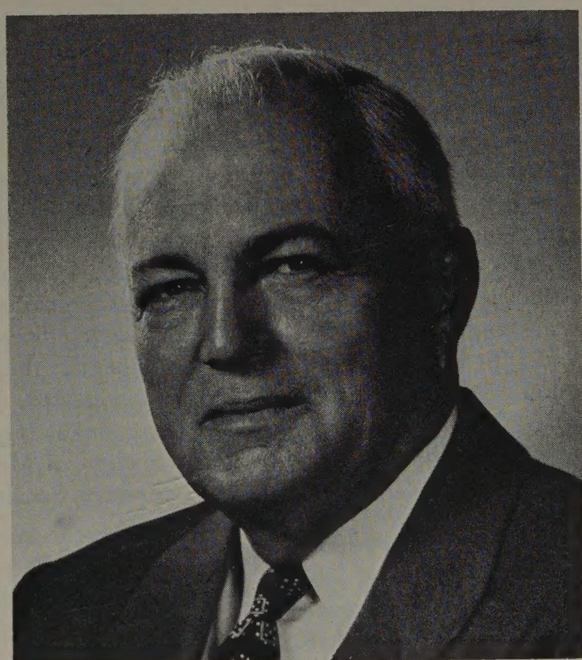
30 Years of Institute Technical Progress

ELGIN B. ROBERTSON
PRESIDENT AIEE

Although in these busy times the Institute is faced with an ever-increasing variety of problems, its most important function is still its technical activity. In his Winter Meeting address, AIEE President Robertson discusses the evolution of this activity during the past 30 years.

IT HAS GROWN to be the pleasant privilege of the President, during the general session at the annual Winter General Meeting, to discuss with his fellow members matters of importance in the administration of the Institute.

There are many things of great importance to the engineering profession that have glamour and color, and an aura of events to come, that beg to be brought to your attention: the struggle for unity in the profession through the Engineers Joint Council and the National Society of Professional Engineers; the effort to raise the educational and cultural standards of the engineer through the Engineers' Council for Professional Development and the American Society for Engineering Education; the need to provide, with our brethren in United Engineering Trustees, a new engineering societies headquarters building; the favorable financial situation of AIEE; the problems arising as a result of the continued expansion of Section, Subsection, Branch, Division, and District organizations; the continued increase in membership and the growing pains accompanying this; the quite surprising trend toward world-wide representation by Institute members; and the many imagination-shaking developments that are taking place and in which the Institute is playing such an important part.



Elgin B. Robertson

All these are important, but I shall discuss the prosaic, run-of-mine, but vitally important technical program of the Institute. It is our reason for being.

THE INSTITUTE THEN AND NOW

THE FUNCTIONS of the AIEE are primarily technical. We all feel this instinctively, and in the last expression of membership opinion on this subject (in the poll of 1949), 85 per cent of us registered this belief. Historically, we have always so regarded ourselves. For 70 years, as far as I know, each administration has made the development of the art and the distribution of technical knowledge its first duty. I am particularly proud to say that we are today continuing to carry on this tradition.

The temptation to become statistical in a presentation such as this is almost irresistible. I am not going to yield to that temptation. I shall simply try to ask you to examine with me the record of our technical operations at the time many of us were beginning to participate in AIEE activities, and then realize what we are doing today.

Thirty years ago (in 1924) I was 30 years old, a designer of electric equipment. I was elected to the grade of Member that year. I was living in the "Roaring Twenties," a postwar period not too different from today in that great things were in the making and it was a period of great activity on the part of everyone.

The AIEE was a revered institution and already of great antiquity, or at least it seemed so to those of us of my generation.

The year 1924 was a great year for AIEE. It celebrated its 40th anniversary in great style, and many important people were on hand for this event. The Winter General Meeting was held in Philadelphia, Pa., during the week of February 4. It was the first time in our history that it had left New York City, and a special effort was made to make it the greatest ever, which it was. Some 1,600 people attended. The *Electrical World* reported that a convention outside of New York was a "practical undertaking." There were eight technical sessions, with more than 20 papers. We established a record in attendance, sessions, and papers.

Among the speakers were President Harris J. Ryan,

Essentially full text of the presidential address presented at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954.

Elgin B. Robertson is president, Elgin B. Robertson, Inc., Dallas, Tex.

Elmer Sperry, Elihu Thompson, and John W. Lieb (the Edison Medalist that year—"the presentation of the Medal being attended by New Yorkers coming over in special cars"). Frank G. Baum talked on "Super-Power." The list of authors and discussers included Hanker, Sels, Evans, Fortescue, Wagner, Summerhayes, Peek, Alger, Karapetoff, Whitehead, Rice, and Dr. Steinmetz (presented posthumously).

Subjects included transmission stability, dielectric losses, electric elevators, meters, telephones, harmonic wave analyzers, telegraph, large generators, and in particular, railroad electrification, for which a nation-wide broadcast from several stations had been set up. Radiobroadcasting, by the way, was then less than 4 years old, although the radio art, according to a Lee de Forrest paper, was 25 years old.

That year, 1924, the AIEE had some 16,000 members, and there were 14 technical committees.

At this year's Winter Meeting we follow the grand tradition. We celebrate our 70th anniversary. The program features more than 100 technical sessions and committee meetings, with more than 500 papers and reports. The Institute has 39 technical committees, and our membership is crowding 50,000, and some of the subjects for discussion make me feel ignorant, subjects such as: Transistors, Cybernetics, Servomechanisms; also, Betatron Donuts, Perception Currents, Pumpless Ignitrons, and the Elusive Lumen. There are also papers discussing color television and nuclear power plants. It seems that we do not know it all, for I find a question as the subject of one of the papers: "What is Ferri-Magnetism?" But to my surprise I find one old friend, "Stray Losses in Transformer Tanks." There are a host of other subjects too numerous to mention.

All this marks progress in the art, and the piling up of knowledge. These are the accomplishments of men—electrical engineers—members of the Institute.

OUR TECHNICAL STRUCTURE

I WONDER if you ever stopped to realize how much time and effort go into what we might call the technical structure of the Institute. There are several hundred committees, subcommittees, and other groups, on which there are thousands of men working. These men handle the solicitation, preparation, and review of the technical papers. They prepare the programs for the meetings, and do an innumerable number of unsung and unnoticed chores. If you had to purchase this time, you would have to pay literally millions of dollars for it. Add to this the cash outlay made by these men and by industry, and you will realize the contribution that is being made on our behalf. In fact, this is what makes this meeting possible. I want to pay tribute to those men who man the technical organization of the Institute. These are the men who contribute more than their proportionate share. They deserve our encouragement and our appreciation. They have gone too long unheralded and unsung.

This brief reminder of our engineering progress has in it hope for the future. By maintaining the freedom of interchange of technical information, by free discussion of advancements in theory and practice, we electrical engineers have done our part in bringing our country to a technological position far in advance of our fathers' wildest dreams, together with good prospects for our freedom in the future. May you and the good Lord help us to preserve that freedom.

In conclusion I should like to pay tribute to the work of our fellow technical societies, and to note the presence of several of their officers at this general session: Ross L. Dobbin, president of the Engineering Institute of Canada; E. H. Robie, secretary, American Institute of Mining and Metallurgical Engineers; L. K. Sillcox, president, The American Society of Mechanical Engineers; and W. N. Landers, secretary, Society of Naval Architects and Marine Engineers.

Electromechanical Equipment Simulates Action of NIKE

Setting up a simulated firing course, these Bell Telephone Laboratories technicians, shown in the picture at left, work with equipment built to study the action of NIKE, the guided missile developed for the Department of Defense. With this electromechanical equipment, the Laboratories, where the NIKE guided missile system was developed, have acquired in a few months essential flight data which otherwise would have taken years to obtain.

On the board are plotted the courses of the simulated missile and target. Associated with this equipment is a computer which controls the electromechanical simulator representing the NIKE missile. With this equipment, accurate data can be obtained, in the laboratory, on the way an actual missile would behave in the air. The NIKE system consists essentially of two parts, an expendable missile and an elaborate control system requiring approximately 1,500,000 individual parts.

The Implementation of a Management Development Program

L. A. RUSS

In today's business and industrial world, the role of the manager has assumed an increasing importance so that the choice of men who will attain managerial positions no longer can be left to chance. A management development program as instituted in one company is discussed as an example which should provide both short-range and long-range benefits.

THERE is a great similarity between "how a manager should spend his time" and the objectives of industry's broad approach to the development of management personnel. A proper use of time is necessary to a manager's effectiveness. If he demonstrates a high degree of effectiveness in an assignment, others are quick to forecast his probable success in a position of greater responsibility.

The work of the business manager is more exacting now than it ever has been. Many factors have contributed to this condition throughout the years, but it has taken the problems of accelerated expansion and pressure since the war to bring the condition into sharp focus. In this relatively new situation, one thing is clear. The choice of management men, and of the qualified reserves who eventually will take over, simply cannot be left to chance.

Industry today is engaged in a systematic search for managerial talent. It is constantly seeking ways to assess human abilities and so eliminate the risk of accident and haphazard choice in the selection of its leaders. It is striving to find its future managers earlier, to keep track of them once they have been found, to challenge them to realize their full capabilities, and to train them more thoroughly in preparation for advancement. It is this kind of action that we begin to know as Management Development—a term which simply means an organized approach which supplements the usual processes of management growth with the advantages of systematic planning, action, and special assistance.

It is not the purpose of this article to discuss the need for management development, or to recommend specifically any particular course of action that might fit the readers' varying needs. Nor will it attempt to reconcile the many solutions to the problem now being tried in industry, in what appears to be a race to accomplish overnight the shortcomings of many years.

Rather, its objective is to discuss a case example of an approach which, although providing definite short-range benefits, is geared primarily to the longer range management personnel requirements of the author's company.

It is generally agreed that effective operation of an enterprise requires the proper application of basic management processes to available resources. These processes—planning, organizing, implementing, co-ordinating, controlling—are just as important to the identification and development of our management people as they are to the design of our new products, the schedule of our production, and the extent of the facilities we will need.

If one aspect of management development is to teach managers how to apply the basic processes of management, then we believe we, as a company, should "apply to the building of managers the things we are building managers to apply." With this principle in mind, our expanding program is the result of learning by experience through the application of methods which, in most cases, is proving to be quite practical.

A PROGRAM FOR MANAGEMENT DEVELOPMENT

FOLLOWING an accelerated period of research, trial, and discussion in staff meetings throughout the company, we reached the conclusion that a thorough program to meet our needs should consist of several phases, and that each should be developed from the preceding phase. This led to our decision in the fall of 1951 to adopt and put into effect a fundamentally basic 4-step approach. Briefly, the first three of these steps are

1. *Position Specifications.* All managers were required to write up a Position Description and a Position Requirement for their respective assignments on a self-analysis basis. Each manager then reviewed his completed write-up with his immediate supervisor so that differences could be reconciled and a common understanding reached as to exactly what is expected of him in his assignment.

In practice, the descriptions provide the basis for periodic review of responsibilities, and are used also for orderly indoctrination of men into new or higher management positions.

The Position Requirements established for each position already are proving of great value as a guide in evaluating the qualifications of candidates for key positions, and in suggesting needed developmental action.

2. *Appraisal.* All individuals included in the program are appraised annually with respect to current performance and potential ability.

Appraisal of performance naturally follows the establishment and review of the specific responsibilities listed in the individual's Position Description, and is intended to re-

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Full text of a conference paper presented at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953, and recommended for publication by the AIEE Committee on Management.

L. A. Russ is director of management development, Westinghouse Electric Corporation, Pittsburgh, Pa.

flect the degree to which all responsibilities are discharged. We are interested in the results that he is able to accomplish, how he goes about getting those results, and his adaptability to the assignment he is in.

Evaluation of Potential in all cases is intended to be a forecast of a man's ability to handle satisfactorily the responsibilities at the next higher management level, based on his qualifications and his present performance.

The Performance part of the completed Appraisal forms the basis for a required discussion of performance with the man being appraised. This annual interview provides an opportunity to review systematically the responsibilities which comprise his assignment, relating them to the standards of performance which are required in accomplishing the over-all objectives of the department of which he is a part.

3. *Inventory*. When Appraisals are complete, the head of each unit prepares a Replacement Table listing each position, the present incumbent in the position, and both a first and a second replacement. Replacements named in this manner represent his best judgment as to the leading contenders for each position in the event of immediate need and are subject to review and approval by higher management.

These steps, Position Specifications, Appraisal, and Inventory, make up the procedural, or "fact-finding," elements of the program. The extent to which these data are put to work at the local line level determines the program's real value. The procedures can bring to light and focus attention on facts not formerly available, and the normal personnel administration phase of managerial responsibility at all management levels is stimulated.

The fourth step—Taking Action—is the most challenging phase of the program. Although entirely different from them, it is based upon information developed as a result of the first three steps.

When we introduced the program we made it clear to our people that a follow-through action in the development of personnel is largely a responsibility of the line organization. In any company with plants and management groups all over the country, there really is not too much that a headquarters group can do to help them with this responsibility other than to approach it broadly and suggest courses of action. However, as the procedures were completed in unit after unit, we began to get the reaction: "We expect to receive a program of follow-through action from headquarters."

This reaction was not unexpected. It did not mean that they were taking no action, as we had ample evidence of it, but it did point up a definite headquarters responsibility to insure maximum benefit to the company.

Necessarily, for a period, our principal efforts were directed toward the evaluation and improvement of procedures for appraising personnel and for planning replacements for key positions. Early in 1953 it became timely to extend the program so that it could serve as a means of marshalling all potential management resources and of providing methods of exposing selected personnel to broadening opportunities.

THE UNDERLYING OBJECTIVES

The extension in the aim of the program necessitated a restatement of the underlying objectives which it is intended to accomplish.

1. The first and most important objective is the identification, evaluation, development, and selection of candidates for the top 750 positions in the company.

2. The second objective is to expose all "Management Development Personnel" to opportunities for self-improvement and undelayed advancement in accordance with their current capabilities. "Management Development Personnel" in our case includes two principal groups:

(*a*). One is composed of all personnel at the level of first-line supervision and above, totaling approximately 7,000.

(*b*). The other includes approximately 3,000 nonsupervisory employees.

These two broad objectives obviously dictate a practical policy of directing attention to the key needs of the company, without losing recognition by all those included that a conscious program is in effect. The inclusion of nonsupervisory personnel recognizes not only the need for early identification and preparation of potential managers, but also the need for developing and retaining their interest in the many opportunities that lie ahead.

Efforts in the direction of carrying out the objectives have resulted in a long-range plan of action which clearly specifies responsibility for follow-through and provides needed tools. The elements of the "plan of action" are related to the objectives.

Our second objective, which will be discussed first, is one in which full responsibility for action lies with local management. Procedural tools and recommended practices constitute the headquarters guidance and direction that are provided.

Broadly, action at this stage includes evaluation, management coaching, and counselling to encourage needed self-development. Such action is intended to result in clearer understanding and improved methods of carrying out present responsibilities, as well as to stimulate men to look ahead and prepare for broader responsibilities.

Evaluation refers to the formal appraisal of personnel with respect to both current performance and potential ability. This action is intended to accomplish three things:

1. To compel supervisors at all levels to evaluate systematically the people reporting to them.

2. To serve as a means of counselling personnel with respect to performance and self-improvement.

3. To furnish an inventory of high-potential people throughout the organization.

Counselling starts with a planned discussion of performance by a supervisor with each subordinate following each annual appraisal. This discussion is intended primarily to help the subordinate see the need for improving his performance, and to stimulate him to make plans to bring about the improvement.

Our aim is to make effective counselling an integral part of the supervisor's operating procedure and relationship

with the subordinate, as we consider it to be the most important element of his responsibility.

In order to implement and strengthen the basic counseling approach, practical self-development opportunities are recommended. Included in these self-development opportunities are Public Speaking, Planned Reading, night school participation in our Graduate Study Program, and many others. For example, our Graduate Study Program in cooperation with 15 universities now includes Business Administration, in addition to technical subjects, and is heavily subscribed. A booklet on "Planned Reading" emphasizes business and management subjects for the benefit of those with the initiative to explore them.

To implement their responsibility further, local management liberally applies new and expanded supervisory training courses developed by our Industrial Relations Department.

Our first objective, as mentioned earlier, is the identification, evaluation, development, and selection of candidates for top-level positions.

The carrying out of this objective places a major share of responsibility on headquarters management. The objective in itself implies application of specific procedures and developmental action to carefully selected individuals, who by virtue of exceptional performance, qualifications, and potential ability, comprise the principal reserve strength of the company. Such headquarters action does not relieve local management of its responsibility in applying the procedures and practices outlined to carry out the second objective in its relationship to these men.

The development of methods of management development and a means of applying them to appropriate levels of maturity and stature has resulted in a carefully conceived plan:

Management Reserve. To meet the near and long-term requirements resulting from existing top level positions to be vacated, or from new top level positions to be created, reserve pools are established. These are divided into three categories:

Category 1 is a pool of 125 men regarded as development material for the top 250 positions in the company. Men for this category are selected from incumbents in the upper 750 positions in sufficient number to maintain the required level of the pool.

Category 2 is a pool of 250 men regarded as development material for the next 500 positions. Selections for this category are made both from incumbents in that range of management positions and from levels of management below that range in sufficient numbers to maintain the required level of the pool.

Category 3 is a pool of not more than 500 men regarded as development material to meet future requirements for Category 2 Reserve. Men for this category are selected from the company's Management Development Personnel group (as defined), who are not already in the Category 2 Reserve.

The records maintained on Management Reserve Personnel by the Management Development Department indicate the function and type of position for which each person is regarded as a potential. This assists in locating candidates for vacancies and replacement tables when local managements have no one to suggest. It also helps to analyze the availability of potential candidates by function and position classification in order that future shortages can be forecast and corrected.

DEVELOPMENT OF RESERVES

There are two principal approaches to facilitate the development of men assigned to the Reserve Categories: Guided Rotation, and Management Training programs.

Guided Rotation denotes a prescribed policy applying to all Management Reserve Personnel.

The Rotation Plan provides for the assignment of a man to another position in the same type of activity, or to a position in another type of activity—the purpose being to broaden the experience of the individual, either through change in function or change in environment.

Rotation is undertaken only when it is possible to move a man into a position where he can be effective, and no rotations are undertaken by creation of positions not otherwise fully justified. Furthermore, men in rotational assignments are measured on performance and results; rotational status does not connote a "learning" period only, but a broadening opportunity, accompanied by the normal requirements and obligations of a regular assignment.

The second method of development, *Management Training Programs*, refers to formal and organized courses of training in basic principles of business and management, and in company organization, policies, and practices. This training deals with managerial responsibility at the general manager level rather than being confined to any one of the principal functions. Because of its nature and specific application to Management Reserve Personnel, it is separately identified to and directed by the Management Development Department.

In our concept we differentiate between Management Development Training and Supervisory Training, although we believe both are necessary. Supervisory Training, directed by our Industrial Relations Department, bridges the gap in an orderly transition from nonsupervisory to supervisory status and may be desirable for several years to help make the supervisor more effective in his present assignment. Management Development Training, on the other hand, is intended to take the high-potential seasoned manager and expose him to study and discussion which will broaden his perspective beyond his present specialty.

In our program we apply specific management courses to men in each of the Reserve categories.

The 125 men in Category 1 all will be exposed, over a period of 3–4 years, to two types of courses. One is the Advanced Management Courses sponsored by the universities, and the other is an "in-company" 2-week course in which Westinghouse policies and practices are presented and discussed.

We currently send 20 men per year to the university Advanced Management Courses and already have a backlog of over 50 men who have attended courses offered by Harvard, Columbia, Pittsburgh, Northwestern, and Stanford Universities. Our first Policies and Practices

Course for 50 men was undertaken in November following several months of preparation.

The 250 men in Category 2 will be sent, over the same period, to our 2-week Business and Management Course. The Business and Management Course is actually a miniature Advanced Management Course employing a case discussion approach to four basic subjects: Business Policy, Organization, Personnel Management, and Financial and Accounting Statements and Controls. Our faculty consists of professors from the University of Pittsburgh. The basic subjects are supplemented by evening discussions led by key company officers on such subjects as: The General Manager's Job, Financial Policy, Planning, Communications, etc.

Two Business Management classes of 27 men each were conducted this summer. The reception and reactions were so gratifying that we already have made plans to accelerate the program by bringing in four groups of 25 next summer. Classes are held in our Educational Center, and the men live together in a local hotel.

Men in Category 3 will be exposed to management training on a very limited, though significant, basis. Fifteen men per year will be sent to a special program at Harvard for a continuous period of 16 months. This is the regular 2-year master's degree program in Business Administration adjusted to eliminate the summer vacation period. Our 15 men will be in a class of 80 men drawn from industry, all carefully selected, under 34 years of age, and having 5 to 10 years of business experience.

We currently are selecting men for the first course which will start in February 1954. Actually we are narrowing our nominations down to approximately 50 candidates from which the Harvard Admissions Committee will select 15 following their regular interview procedure. These men will be removed from their present assignments, and on completion of the course will be assigned to positions which present an adequate opportunity for each man to broaden himself and assure a comprehensive scope of experience.

Other phases of headquarters responsibility concern a realistic use of the Management Inventory in the process of filling vacancies and designating replacements for the top 750 positions in the company. It is our aim to avoid the "blocking" of men ready for promotion in cases where they are thwarted by lack of opportunities within their own unit.

Our company policy in regard to the promotion of high-potential Management Development Personnel is stated very simply:

"In the filling of management positions, the man with the greatest potential ability should be assigned regardless of other considerations, such as age, service, or experience, if he can meet the minimum requirements of the position within a reasonable time."

THE CHALLENGE

The emphasis that has been placed on these objectives and plans should not overshadow the need for establishing the entire proceedings as a normal business process and not as a special program or activity under the stress of some temporary enthusiasm.

A broad outline of our program has been given as a case example. We feel that the program has been stimulating to the morale of our management people and that we cannot afford to have other than an aggressive follow-through. It provides a challenge but also imposes an obligation.

Although many companies have programs which differ in varying degree, those that attempt to analyze their effectiveness are in full agreement that there are no quick and easy methods for growth and development of able personnel. Individual growth is a slow process, and the essential ingredients are time and patience, together with a conscious plan of action.

Diesel-Electric Sets Flown to Greenland

For the second time Military Air Transport Service *C124* Globemasters have carried stationary electric power to the United States Air Force in Greenland.

The first transport of a large 13-ton diesel-electric set was made in April 1953 from Lowry Field, Denver, Colo. The second journey originated recently at Chanute Air Force Base, Ill. Instead of one engine as on the first journey, this time there were two weighing a total of 64,000 pounds. The two Caterpillar *D397* diesel-electric sets each are capable of producing 300 kw.

The first journey of the electric set was accomplished in 3 days with stops at Westover Field, Mass., and Goose Bay, Labrador. This electric set took over the power requirements of four smaller engines which had seen long service and were in need of some repair.

The picture at left shows the 16-ton engine and generator of the diesel-electric set being loaded into a *C124* Globemaster for shipment to Greenland.

The 50th Anniversary of the Cross-Field Dynamo

EMANUEL ROSENBERG

The cross-field generator or Rosenberg dynamo, invented early in 1904, still is used for many purposes. Some of the illustrations, actually reproductions of ones first published almost half a century ago, will seem like repetitions of those in recent publications.

My experiments at the end of February 1904 and beginning of March 1904 had for their purpose the design of a d-c generator for train lighting which contained an exciter within itself to supply an exciting current which reversed with reversal of the rotation, so that certain commutator brushes should supply current of constant direction, independent of the direction of rotation. The result was the cross-field dynamo, a machine with fundamentally new qualities. The patent application was filed in the German patent office on March 28, 1904. The first real train-lighting machine of this system was built for the Royal Bavarian state railways and made its trial trip from Munich to Landshut on August 26, 1904. On February 14, 1905, I read a paper before the Electrotechnical Society in Berlin, Germany, and exhibited one of a greater series of these train lighters. A few weeks later I repeated the lecture and the exhibition in the Electrotechnical Society in Vienna, Austria.

One of my first tests in the Allgemeine Elektricitäts-Gesellschaft (AEG) shops in Berlin during 1904 was to study the superposition of a constant 2-pole exciting field with a 4-pole main field. In an ordinary 4-pole field structure with four commutator brushes a ring-wound armature was used, see Fig. 1. The coils *I* and *IV* were fully excited from an outside source whereas the current in coils *II* and *III* was reduced by means of a parallel resistance. The resulting strength of the four poles was that of a superposition of a 2-pole field $\frac{s}{n}\frac{s}{n}$ with a 4-pole field $\frac{S}{N}\frac{N}{S}$. The brushes *1* and *3* should supply the exciting current for the 4-pole field. The current induced in the armature by the 4-pole field would have been sent into the outside circuit from some points in the connections of brushes *2..4* and *1..3*. I mention this first experiment of mine, which was fully treated in the patent specifications,[1] because more than 40 years later the Westinghouse Electric Corporation developed their amplifier Rototrol on this principle.[2,3]

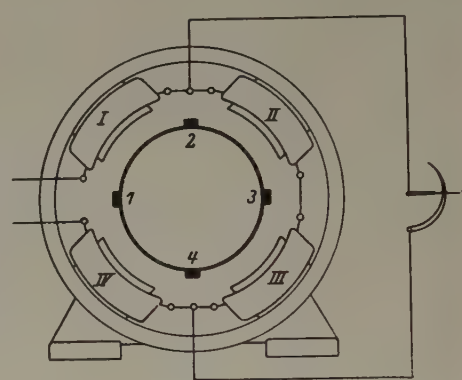


Fig. 1. First experiment: Superposition of a 2-pole and a 4-pole field, ring-wound armature

(*Taken from Gleichstrom - Querfeldmaschine (book), 1928, p. 87, Fig. 102*)

CROSS-FIELD DYNAMO

I soon found that I could get a greater output from my experimental machine if I excited poles *I* and *II* with equal strength and the same polarity, poles *III* and *IV* with equal strength and opposite polarity, short-circuited the brushes *1* and *3*, and used the brushes *2* and *4* as main brushes of constant polarity. The dynamo could be made with two poles as shown in Figs. 2*A* and 2*B*. The letters *n* and *s* in the middle of the pole shoes show the primary field, while the armature reaction of the current flowing through the short-circuited auxiliary brushes *bb* creates a field *NS* in the horns of the pole shoes: the secondary field

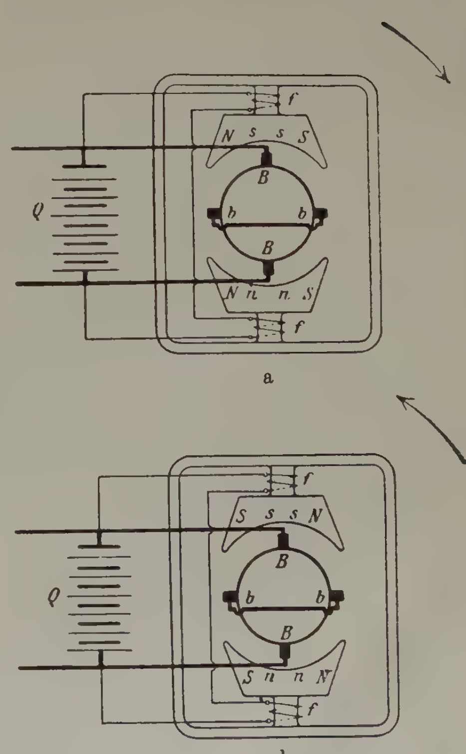
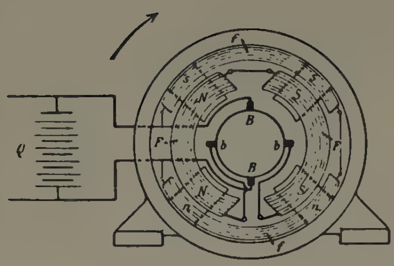


Fig. 2A and B. Cross-field generator with armature excitation (1905)

A special article recommended for publication by the AIEE Committee on Rotating Machinery.

Dr. Emanuel Rosenberg is now at Calle 62, No. 4–31, Bogota, Colombia.



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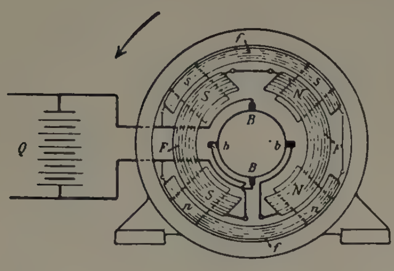

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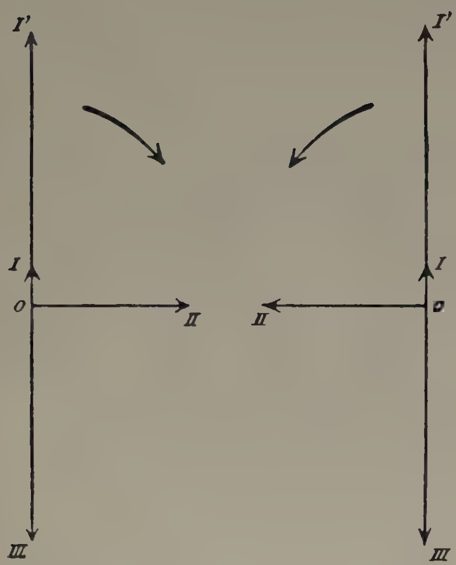
Fig. 3A and B. Cross-field generator with 2-phase stator windings (1905)



a b

Fig. 4A and B. Diagram of ampere-turns (1905)

that reverses with reversal of the rotation. Figs. 3*A* and 3*B* show a manner of carrying out the same purpose by providing a magnet structure with 4-pole pieces and a "2-phase stator winding," without short-circuiting the auxiliary brushes. It was explained in my patents and papers, but in actual practice I preferred to use the design of Fig. 2. The diagrams of Figs. 4*A* and 4*B* are valid for both forms of the cross-field dynamo.[4] *OI* is the primary field; *OII* is the secondary field shifted against the primary by 90 electrical degrees; *OIII* is the tertiary field caused by the reaction of the main current. It is in strict opposition to the primary field and must be compensated through a component *II′* in the same direction as the primary field. It is explained in the papers of 1905[4]: "If it was a machine for ordinary purposes, this number of ampere turns *II′ would be produced by a series winding which would compensate the armature reaction for every value of the current.* With train lighting machines driven from a car axle the primary exciting coil will be so dimensioned that already from the start the number of ampere-turns is represented by the line *OI′*." This referred to the German Train Lighting Company, Gesellschaft für Elektrische Zugbeleuchtung (GEZ) system which worked with constant adjustable current. See Fig. 5.

WOODBRIDGE TRAIN LIGHTING SYSTEM FOR CONSTANT VOLTAGE

The Electric Storage Battery Company, Philadelphia, Pa., obtained a license for the Rosenberg dynamo in 1910 and J. L. Woodbridge used it as a generator for constant voltage to charge every cell of the lead battery with 2.25 volts. The diagram of connections is shown in Fig. 6.[5] The cross-field generator with the short-circuited auxiliary brushes *bb* and the main brushes *BB* has a series or compensating field winding *F*, which compensates the armature reaction, and a weak primary field coil *f* which can receive positive or negative controlling current through a Wheatstone bridge *W*, according to whether the voltage is below or above a certain value. The diagram is a little complicated by a resistance *r* which proved unnecessary but was provided to overcharge the battery in daytime if need be. The resistance *r* could be connected in series with the bridge *W*, could be short-circuited by the switch *h*, and always was short-circuited by buttons *k* of the main switch *H* when the lamps were on. Two sides of the Wheatstone bridge *W* marked *xx* have constant resistance while the other sides marked *yy* consist of thin iron wires in glass bulbs filled with rarified hydrogen. The points *I* and *III* of the bridge are normally connected across the full generator voltage; the coil *f* is connected across the points *II* and *IV* of the bridge. With a definite voltage across the points *I* and *III*, the iron wires *y* show the same voltage drop as the resistance members *x* and no current flows through the primary coil *f*. The residual magnetism of the generator produces current between the auxiliary brushes *bb* which in turn produces the voltage of the main brushes *BB;* the armature reaction of the main current is compensated at every speed by the coil *F*. If the voltage is lower, a smaller current flows through the bridge *W*. Already with a very small reduction the resistance and therefore the voltage across the incandescent iron wire *y* is sensibly reduced, and a current flowing through the primary coil *f* magnetizes the field structure in the same direction as the coil *F*. With an increase of the voltage over the normal voltage, the current in the coil *f* is reversed and opposes the coil *F*, for the residual magnetism

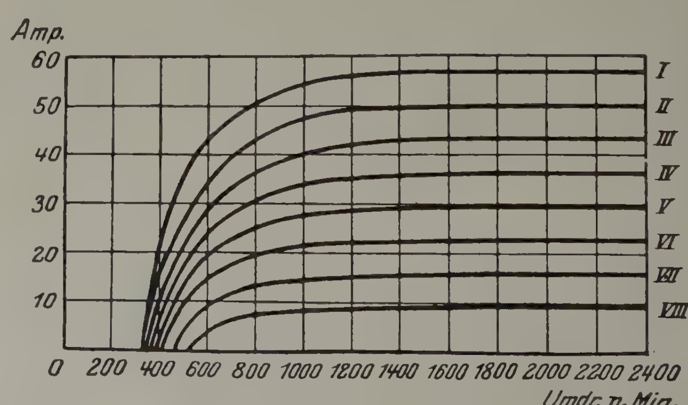


Fig. 5. Current dependent upon speed in constant-current system (1905)

would induce at high speed too high a voltage and therefore too high a charging current. Fig. 7 shows constant voltage of 36 volts (16 cells) at 600 to 2,200 rpm. Also at higher speeds the voltage would not change.

R. C. Hull simplified the arrangement by cancelling one of the branches of the bridge and connecting one end of coil with the short-circuited auxiliary brushes *bb*.

Others who used an electromechanical appliance to obtain constant voltage with the cross-field generator found like Woodbridge that it is very useful to use the compensating coil *F* and to regulate only the diminutive current in the controlling coil *f* because a regulator for such a small current is cheap and durable.

Although the smallness of the current's magnitude in the controlling coil, when the train is running at full speed, may not have been published, a characteristic curve of a series-excited searchlight generator for 60 volts, 200 amperes was published in 1906, see Fig. 8 which shows at no load, with exciting current zero, 70 volts.[6,7] While the residual magnetism of a conventional generator is 1–2 per cent it can give full voltage in a cross-field generator. The generator had a cast iron yoke. Although the no-load voltage with a cast steel or laminated steel yoke would be smaller, a controlling coil for a constant-speed generator can work with a very small positive or negative input.

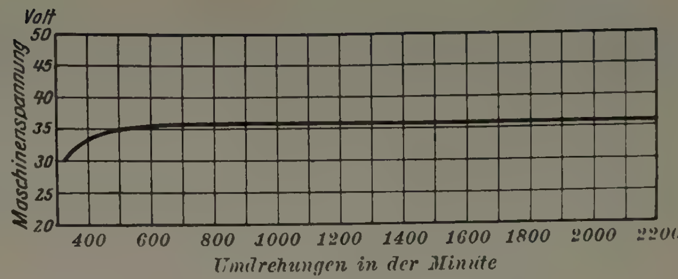
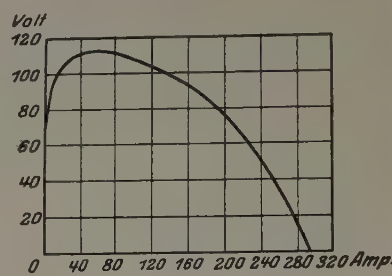


Fig. 7. Woodbridge speed and voltage

(*Electrical World, November 1, 1913, p. 916*)

Fig. 8. Series-excited searchlight cross-field generator (1906)



REGULATING POLE CROSS-FIELD GENERATORS

In 1907 I severed my connection with AEG and thereafter hardly ever was consulted by the licensees about problems of the cross-field dynamo. It was manufactured by AEG, SSW, and their affiliated houses for the train lighting company and by Mather and Platt Ltd. for British and colonial railways without important changes in design, but little was published. In 1925, with the Austrian Elin Company, I introduced regulating poles as a valuable addition for arc welding generators.[8–9] Later a certain shape of curve or the fitting of windows in the outside shell of the regulating pole allowed refinements of the welding generator. The improvements were very carefully observed by competitors. AEG who had used an arrangement by Krämer for welding, returned now to cross-field generators, also Kjellberg and for some time Siemens-Schuckert; in Czechoslovakia, Hungary, Italy, England, and the United States, cross-field generators were built to achieve with other coil arrangements similar purposes which Elin had obtained with the regulating pole and other improvements. Commutating poles have been used for main current by Elin since 1927. No commutating coils were used for the auxiliary brushes which carry a much smaller current since their commutation was always excellent without the use of these poles. Fig. 9 shows the cross section of the generator for welding purposes as it was made in 1936.[10] *MC* are the series field coils with cooling fins; *CP* is the commutating pole with its coil *CC;* *W* are circular windows in the regulating pole's outer shell, which surrounds an inner piston that can be moved lengthwise by means of a flat threaded screw actuated by a hand wheel *H*. The windows *W* are dimensioned so that the smallest iron section is only about 4 per cent of the full section of piston and shell together. The lower or "fixed" pole is a combination of a permanent magnet tube *PT* and a magnetic shunt tube *MT* of mild steel parts with a nonmagnetic air gap *IW* between them. The permanent magnet *PT*, marked by heavy shading, is of sufficient section and length to send through the armature, when the electric circuit is broken, such a flux that correct polarity results even if a reversed current, sent from outside through the generator, has reversed the polarity of the mild steel parts of the field structure. Since 1936 great improvements have been made in permanent magnets by Philips and others. Due to this, the fixed poles have been reduced appreciably in size.

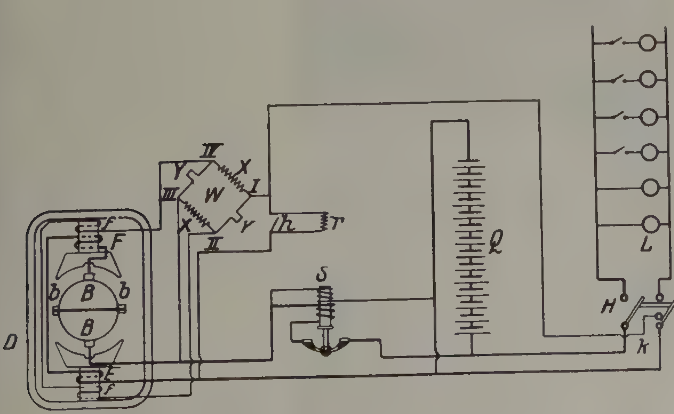


Fig. 6. Woodbridge constant-voltage train lighting system

(*Electrical World, November 1, 1913, p. 916*)

Fig. 10 shows an experimental machine with a stator winding distributed in slots which was made by Elin in 1930.[10] The characteristic curves of this machine were similar to that of the standard cross-field generator with salient poles. The dimensions could have been reduced, but for welding purposes there were no advantages as to costs and manufacturing. Thus the standard design with salient poles and circular coils around the poles was kept.

The patent applications and publications and the suc-

cesses in the welding technique since 1925 resuscitated the interest in the cross-field generator, and there came many suggestions and applications from other inventors in the same way as after the 1904 invention. Although, with the exception of Woodbridge's constant-voltage system, none of the other suggestions after 1905 obtained practical importance as far as my knowledge goes, there was remarkable development at the end of the 1920's and in the 1930's.

PESTARINI'S METADYNE

PESTARINI has used since 1930 the principle of armature excitation and of two fields with half a pole pitch distance for many different purposes, for instance, for the conversion of constant direct voltage into constant direct current of variable voltage. He called all these machines metadyne and treated the original cross-field generator as a special case of the metadyne. The cross-field generator also was investigated mathematically, by Italian authors such as A. Carrer in a paper dated November 1939 which considers all my publications from 1905 to 1939 and acknowledges the suggestions made by Professors Giancarlo Vallauri and Giuseppe Massimo Pestarini.[11] I believe that Pestarini worked for a time in Schenectady and there revived the memory of the cross-field generator.

AMPLIDYNE

IN ESSENCE, the excitation chosen by Woodbridge and described in 1913 was repeated in 1939 by Alexanderson and his associates in the amplidyne.[12] They used a small current in the control coil of the compensated cross-field generator to regulate huge machines and apparatus. The interval of 26 years is the remarkable thing. The train lighter of Woodbridge, even with the solid cast iron or steel yoke, would have served for many of the problems of an amplifier: to produce with a small primary controlling current great, quick, nearly proportional changes of the armature current; in many cases without disturbing oscillations. It was a fit tool for amplification. The General Electric Company (GE) improved it in 1939 for this purpose by using a laminated yoke, by distributing the compensating winding in stator slots, by using commutating poles: things which were well known, not necessary for some other purposes but very useful for an amplifier. Some things were added which, in my opinion, have no great effect, like additional windings in the secondary stator axis excited by derivations of the main current or voltage. In my designs, I always avoided such excitation which makes the generator dependent on the direction of rotation.

The hundreds of interesting problems which were solved immediately with the amplidyne show clearly that the time was more than ripe for a dynamic amplifier, even if it was not so in 1913. How to explain the delay of 26 years? I believe that the cross-field generator was forgotten entirely in the GE offices although they had acquired a license in 1907 and although the train lighters for the Electric Storage Battery Company were manufactured in GE shops. But

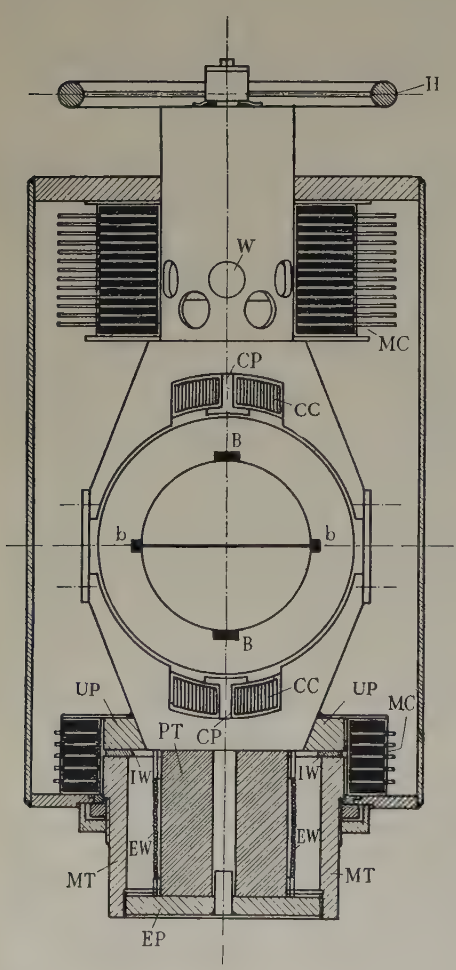


Fig. 9. Cross-field generator with fixed polarity and regulating pole with windows

(*Journal, Institution of Electrical Engineers, September 1939, p. 424*)

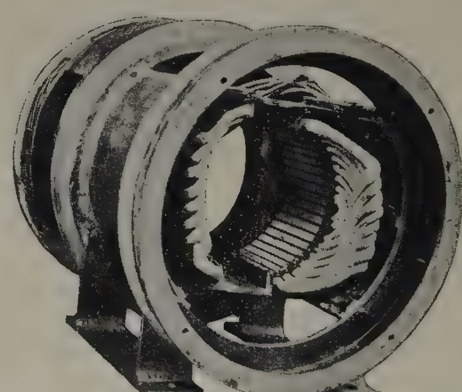


Fig. 10. Experimental stator with distributed winding, 1930

(*Journal, Institution of Electrical Engineers, September 1939, p. 427*)

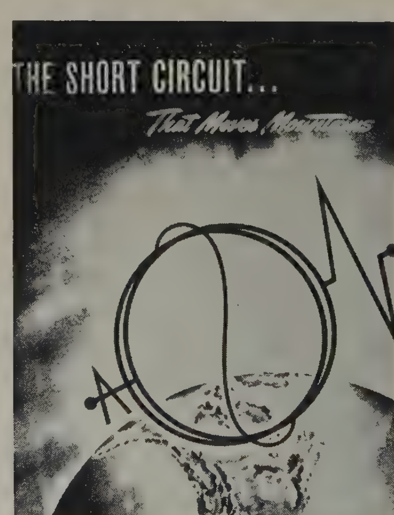


Fig. 11. General Electric Company symbol: The short circuit that moves mountains

the Storage Battery Company withdrew from train lighting business, and the Safety Car Heating and Lighting Company who took over their business most likely preferred to continue with their old system, especially as the war of 1914–18 did not make it desirable to propagate something new, if railways were satisfied with the known system. The Westinghouse Corporation built a cross-field welding generator, the design of which was very near to the Elin design, except for the regulating pole, which they had acquired from Kolben and Company, Prague, Czechoslovakia. With GE, the cross-field dynamo, like the sleeping beauty of the fairy tale, had slept for many years; but when Prince Charming awakened her, life started at once in a hundred rooms of the enchanted castle. Dozens of departments of GE found suddenly they had use for a rotating amplifier and enormous ingenuity was shown in all the branches of engineering. The pamphlets written by GE men also show this ingenuity. One could not easily imagine more striking symbols than Figs. 11 and 12 for the "short circuit that moves mountains."

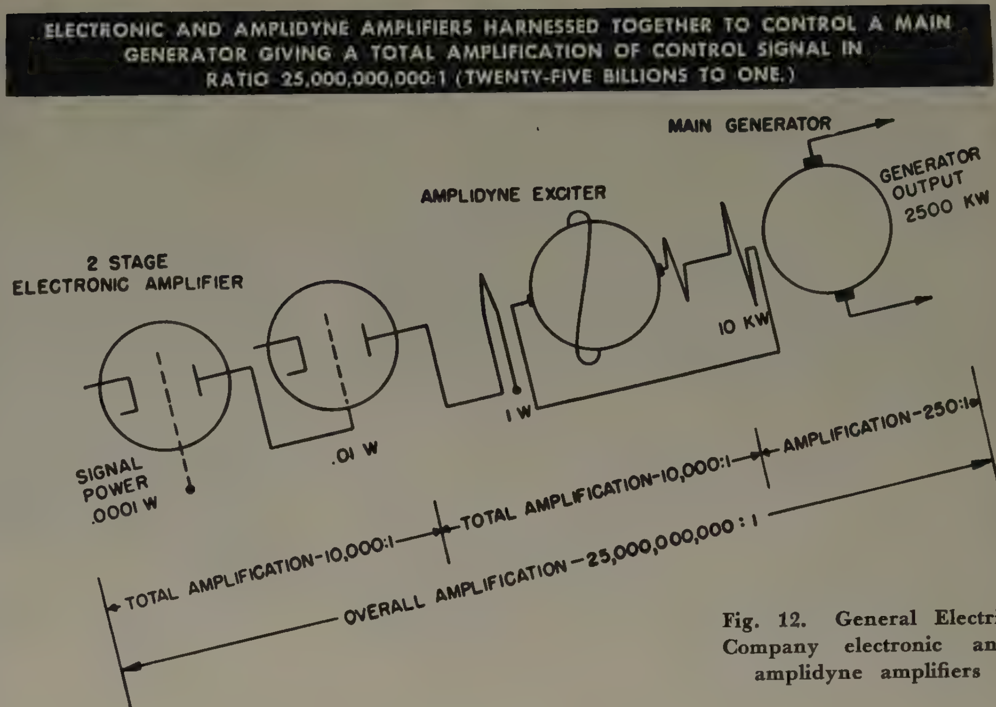


Fig. 12. General Electric Company electronic and amplidyne amplifiers

Other engineers used the cross-field generator as amplifier and for other purposes with certain changes and other special names. J. Griffin of Crompton, Parkinson Ltd., London, England, employs in the magnicon short pitch armature coils (4-pole winding in place of diametrical connections), which in my opinion is without importance. But a very nice feature in its application as exciter for small alternators is a primary pole with a fully saturated main part and other unsaturated parts opposing the main pole and permitting a compounding of the alternator with an exciting current derived from the alternating voltage by means of a dry cell rectifier.[13]

THE ENDLESS CHAIN OF INVENTIONS

Schiller's Piccolomini admonishes his son: "This is the malediction of the wicked deed that it must engender wicked things in endless chain." Not every invention is a wicked deed, but it often does engender new inventions in endless chain. The Nernst lamp which was invented at the end of the 19th century was hailed as a marvelous invention, but could not stand the competition of the metal wire lamp. To introduce it, the AEG had to develop an effective and cheap resistance which prevented the current increasing with increasing voltage: the incandescent iron wire in bulbs filled with rarified hydrogen. This iron wire played a part in train lighting at the beginning of the 20th century. Wittfeld, the leading official electrical engineer of the Prussian Railways, did not trust the existing systems with generators, driven by belts from the car axles, electromechanical regulating apparatus, and switches. On his instigation Büttner of the German Akkumulatorenfabrik, with the active co-operation of various AEG departments, suggested iron wire bulbs in series with every lamp; an aluminum cell replaced the automatic cutout between generator and battery; iron wire bulbs were used in the excitation circuit of the generator to limit the exciting current in spite of rising voltage when charging the battery; to avoid belt, chain, or gear the generator armature was put directly on the car axle in some cases. Then I invented a generator which could give the same polarity independent of the direction of rotation. It had new qualities, among others the one that a very weak primary excitation was needed. Woodbridge used it to create a constant-voltage train lighting system, while Büttner's system had been one of constant adjustable current. In 1905 the new cross-field generator was suggested as useful for arc welding and searchlights (by Essberger of AEG and Dr. Liebenow of Akkumulatorenfabrik) and I designed it with mere series excitation. Twenty years later arc welding developed to an unexpected degree, and the cross-field machine with a regulating pole which I designed with Elin, proved an efficient tool. Pestarini, since 1930, has used a dynamo with two fields at electrically right angles to each other for new problems like converting continuous current of constant voltage to continuous current of constant strength and calls these electric machines metadyne. Since 1939 Alexanderson and associates of the GE have been using the cross-field generator with compensating winding and controlling coil as amplifier (amplidyne), to obtain great changes in the armature output by means of diminutive changes of control current; other makers designed similar amplifiers with certain changes and with other trade names.

I was surprised and delighted about every one of these new applications by Woodbridge, Pestarini, and Alexanderson. While many other inventions have become obsolete through the development of the art, it seems that the cross-

field generator continues to be useful although half a century has passed since its conception.

In 1928 I published a booklet "Die Gleichstrom-Querfeldmaschine" (The Continuous-Current Cross-Field Dynamo) which contained my papers written up to that time and details about the history of the different stages of the invention.[14] It is out of print now. Some additional facts are published in another book of mine "Der Werdegang eines Ingenieurs" (An Engineer's Career).[15] In other books statements have appeared which are not correct, for instance, that Déri was the inventor of the cross-field generator, (Kurt Seidl, Vienna 1951); I also believe I have seen an American pamphlet which states that the "short circuit that moved mountains" was invented by American engineers. That is not correct: I am an Austrian. In some of the papers the theory of the cross field is developed as if it were a brand new truth. Such things can well be understood, considering that half a century has passed since the invention and that wars and political disturbances have caused irregularities in schools and libraries of many countries.

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A Monoscope Tube for Computer and Other Applications

JOHN HARTMANN
ASSOCIATE MEMBER AIEE

Electronic computers need a display apparatus which will record large quantities of output data rapidly. An optical system in which the output characters are displayed on the screen of a cathode-ray tube has been developed and is offered as an output for computers and other devices.

THE USE OF electronic computers in scientific problems and business-machine operations has shown a need for high-speed display apparatus to record the large quantity of output data furnished. Recording techniques now being used have been classified into three catagories; mechanical, magnetic, and optical.[1] Of these three the mechanical systems can produce a printed output directly, but they are limited in speed of operation; the magnetic and optical systems require an additional step or steps to produce readable results.

One form of the optical systems uses a cathode-ray tube to display the output of the computer. This type of display can be used for high-speed character formation and is both practical and flexible. In order to record the information permanently a further process is required.

Xerography is one such process and it is especially attractive in applications which require immediate and legible results. The photographic process, though taking slightly longer, is extremely versatile and has been used widely for recording. High-sensitivity emulsions are available and make possible direct recording from a cathode-ray tube face at high rates of speed.

The formation of the output characters on the screen of the cathode-ray display tube can be accomplished by several methods.[2] One such method utilizes monoscope tubes, such as the Du Mont *K1043* types.

THE MONOSCOPE TUBE

THE MONOSCOPE TUBE is a form of cathode-ray tube in which the electron beam strikes a target instead of the

A special article recommended for publication by the AIEE Subcommittee on Electron Tubes.

John Hartmann is with Allen B. Du Mont Laboratories, Inc., Passaic, N. J.

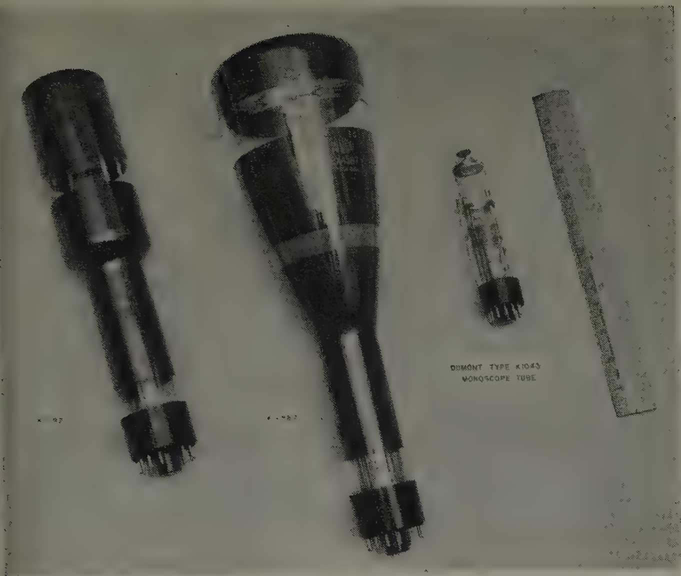

Fig. 1. Monoscope tubes which utilize electrostatic focus and deflection

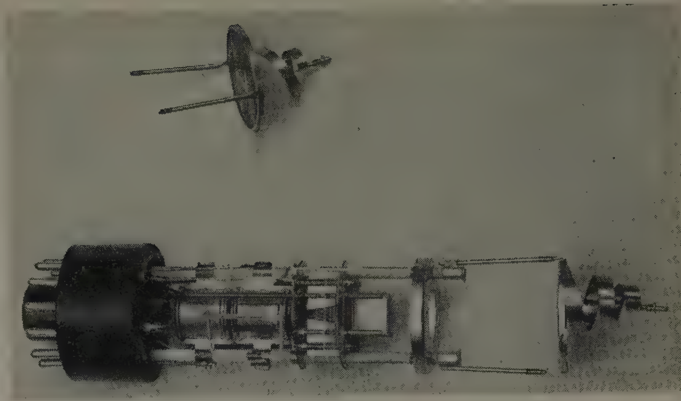

Fig. 2. Mount and target structure of the cathode-ray tube type K1043

usual screen. The target contains secondary emitting material and the output current from the monoscope tube is proportional to the electrons emitted from the target. By printing the desired character on the target and then scanning this target area with an electron beam, a varying output signal is generated.

If the same scanning frequencies are applied to the deflection plates of a display tube and its electron beam intensity is controlled by the monoscope tube output signal, the target character will be reproduced on the phosphor screen of the separate display tube. The size of the reproduced character may be made smaller or larger than the original character by adjustment of the scanning voltages on the display tube.

Prior to the advent of flying-spot scanners, monoscope tubes were one source of television test patterns for many years. These tubes had relatively low output currents and required high-gain and high-impedance circuits. To obtain good definition, about 500 lines, and keep the target size reasonable, a small target current must be used, which results in a low output signal. If the beam current were increased to increase the output, the spot size would be increased with a resulting lower definition. With a higher output current, though, less amplification would be required.

Several monoscope tubes are shown in Fig. 1, all of which use electrostatic focus and deflection. The *K1092* type has a minimum 200-line definition on the target. Typical operating conditions are 2,000 volts on *A2* and 2,250 volts on the collector. With an average beam current of 6 microamperes an output of 0.25 volt is obtained across a 39,000-ohm resistor. The target may contain any type of character desired. *EX4587* is a special tube containing the standard Radio-Electronics-Television Manufacturers Association pattern. Operating conditions are similar to standard monoscope television pattern tubes like the Indian Head design except that electrostatic deflection is used. The *K1043* tube

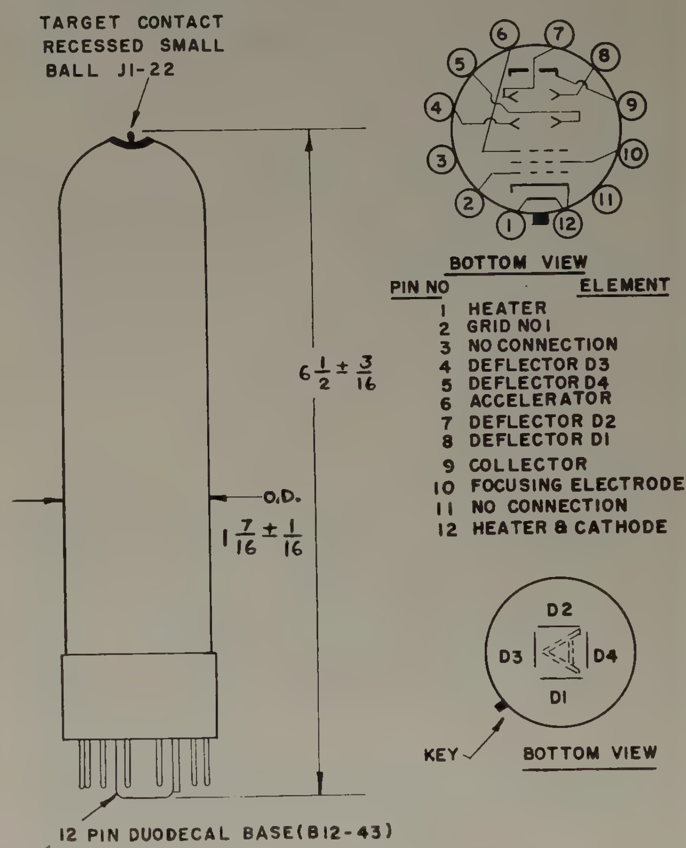

Fig. 3. Schematic of tube type K1043

has 30-line definition, a beam current of approximately 100 microamperes, and develops a minimum of 1.5 volts across a 40,000-ohm resistor.

MONOSCOPE REQUIREMENTS

The *K1043* monoscope tube was designed for the Eastman Kodak Datascope which is a form of high-speed printer. In the original tubes a single plate was used which contained the alphabet and numbers. An area about the size of one character was scanned by the electron beam. This scanned area then was positioned on the required character by applying direct positioning voltages to the

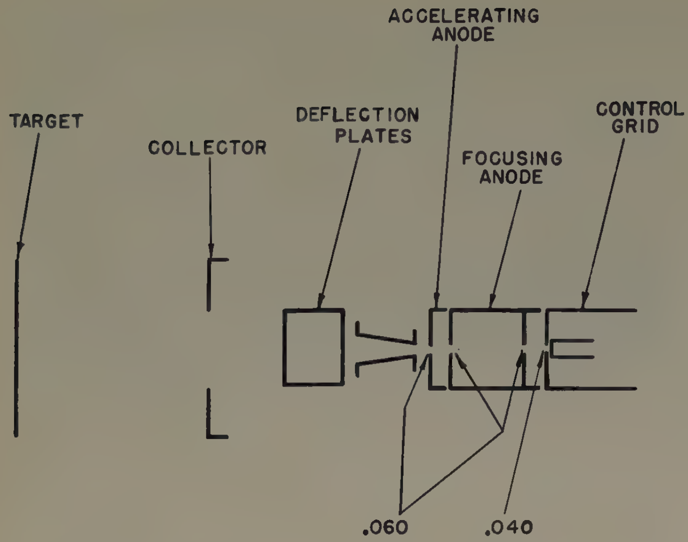

Fig. 4. Basic gun arrangement

plates, and when the proper position was obtained the electron beam was gated on. From the tube manufacturing angle this had many advantages in that one tube could contain all the characters. The disadvantage arose from complicated computer problems where the entire operation would be a loss should the monoscope tube fail. With the tubes containing only one character it is a simple matter to check back to find out which tube has failed and insert the proper number or character in the results.

To operate satisfactorily in the Datascope, the monoscope requirements were as follows:

(*a*). The resolution capability had to be sufficient to resolve 30 lines on the character using a second-anode supply of 1 kv and single-ended deflection.

(*b*). The uniformity of these tubes, with regard to spot focus, had to be held sufficiently close so that a common focusing control for any number of tubes could be used without falling short of the 30-line resolution mentioned previously.

(*c*). The tube design must not be such that shading difficulties would be encountered as the scanning beam approaches the deflection plates in forming a raster 1.5 times the height and width of the largest letter.

(*d*). The total distributed capacity between the target electrode and all other electrodes could not exceed 7 micromicrofarad ($\mu\mu$f.)

(*e*). The sum of the error in alignment of the axis of the printed character on the target electrode with respect to the horizontal or vertical plate alignment plus the error in the horizontal-vertical plate alignment could not exceed a total of 3 degrees.

(*f*). The undeflected spot must fall within 5 mm of the center of the character printed on the target electrode.

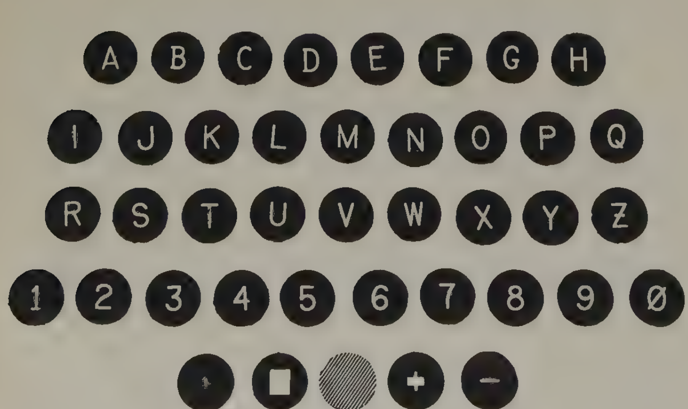

Fig. 5. Some of the presently available letters, numbers, and symbols

The mechanical features of the *K1043* are shown in Figs. 2 and 3.

Deflection Sensitivity: for an anode supply of 1 kv *D1-D2* (horizontal) 190 volts, plus 0 minus 40 per cent for a spot deflection 1.2 times the height of the printed character. It is convenient to express both the horizontal and the vertical deflection sensitivity requirements in terms of the character height since the height of most characters is the same whereas the width varies considerably.

D3-D4 (vertical) 160 volts plus 0 minus 40 per cent for a spot deflection 1.5 times the height of the character.

Typical operating potentials are as follows:

First anode	290 volts
Second anode	1,000 volts
Target	1,000 volts
Collector	1,250 volts

When operated at these potentials the tubes have the following characteristics:

1. With the focused electron beam scanning a portion of the target plate, including both background and character elements, and with a suitable negative peak-current indicating device connected in series with the target electrode, it will be possible to adjust the grid bias for a negative peak target current of 17 microamperes (μa) without exceeding either of the following limits:

(*a*). A cathode current not greater than 250 μa.

(*b*). The cathode current minus the first anode current will not exceed 140 μa.

Without changing the grid bias or electron beam conditions from the foregoing conditions and with a suitable positive peak indicating device connected in series with the target electrode, the positive peak target current must be 30 μa or more. The minimum peak-to-peak signal output developed across a 40,000-ohm 1-per-cent resistor connected in series with the target elecrode must exceed 1.5 volts.

TUBE ASSEMBLY

In Fig. 4 the basic tube arrangement is shown. The gun is a triode type in order to meet the common focusing voltage requirement and also to obtain a short tube. The apertures are 0.060 inch and the grid-cathode structure is the familiar type used in cathode-ray tubes. With this type of gun construction the best focus was found to fall between

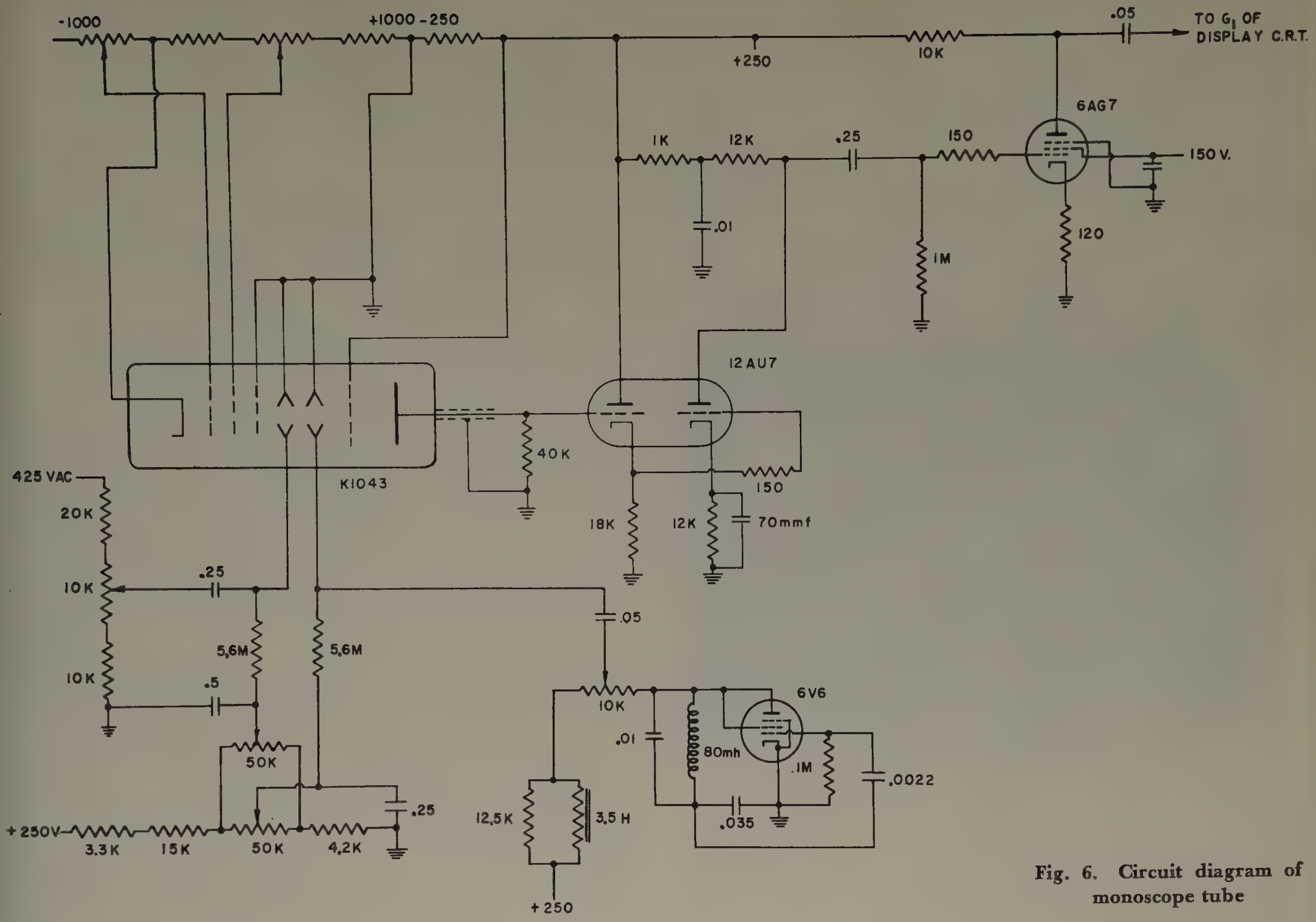

Fig. 6. Circuit diagram of monoscope tube

280 and 295 volts with the greater number of tubes on bogey. This is a total variation of 5 per cent and it is a smaller variation than could be obtained with a tetrode gun.

The deflection plates are of the box-type construction and have a straight incline. A very strong deflection plate assembly is obtained by the combination of the boxplates and the mica supports.

Just above the top deflection plates is the collector disk, which contains a 9/16-inch hole to allow the deflected beam to pass through without being cut off. The collector disk is operated about 250 volts above the target potential in order to collect the secondaries emitted from the target.

Fig. 5 shows some of the target characters which are presently available. The letters and numbers are all familiar. On the bottom row are several special symbols, the first one is a marker, the second a fogging raster, the third is a special target, the fourth is a combined marker and fogging raster, and the last symbol is a dash.

When the first experimental tubes were made several characters were printed on aluminum sheet and then mounted into the tube. These tubes were then processed on the pumps with an extended bakeout and exhaust schedule. After they were tested and operated and the targets were found to be stable, it was decided to have all the characters printed.

After basing and cathode seasoning the tubes are aged in a special rack. Sweep voltages are applied to the deflection plates at suitable frequencies to form a 50-line raster and the cathode current is adjusted to 150 μa. After 24 hours seasoning the tubes are tested, the readings recorded, and then the tubes are placed back in the seasoning rack. They then are operated for 48 hours after which they are retested. The average tubes require approximately 96 hours to stabilize their targets. Operating at higher cathode currents did not show any appreciable shortening of the stabilizing period.

The target electrode consists of an oxidized aluminum character with a carbon background. The over-all height of the printed capital letters is 0.475 inch. A carbon background is provided with sufficient size to permit the character to be scanned with a raster 0.73 by 0.58 inch centered on the character. Both the carbon background and the aluminum character must be free from any blemishes which would be noticeable on the face of a cathode-ray tube when a 50-line televised reproduction of the character is examined.

Aluminum was chosen as the secondary emitter surface because of its stable characteristics and ease of handling. Carbon was picked for the background material in the belief that it would be nonemitting and that it could be applied very easily.

CIRCUIT DESCRIPTION

In Fig. 6 is a simple circuit diagram for operation of a monoscope tube. Sine-wave sweep voltages are em-

ployed the same as in the tube test unit itself. The proper tube potentials are obtained from a voltage divider across the power supply. The high-frequency scanning voltages are obtained from a *6V6* tube operating as a free-running Colpitts oscillator which generates a 7-kc sine wave. The oscillator output is supplied to the monoscope tube deflection plates by means of a 0.05-microfarad (μf) coupling capacitor. Single-ended deflection is used on both sets of plates. Centering voltages are applied to the plates from 50,000-ohm potentiometers.

Fig. 7. K1043 monoscope tube test unit

The monoscope target current flows through a 40,000-ohm resistor in the grid circuit of one-half of a *12AU7* tube connected as a cathode follower. The output developed across the 18,000-ohm cathode load resistor is directly coupled to the grid of the second half of the *12AU7*. This second section acts as a video phase inverter, the output of which is coupled to the *6AG7* video amplifier grid through a 0.25-μf capacitor. The 70-$\mu\mu$f capacitor in the video-phase-inverter cathode circuit is used to improve the high-frequency response.

The output of the *6AG7* video amplifier may be resistance-capacity coupled to the grid of a display cathode-ray tube. Deflection voltages for the display tube are obtained from the monoscope tube sources through suitable phase-shifting networks. A small amount of phase shift would exist between the two tubes if they were connected directly. This shift shows up as a second character slightly displaced from the first, somewhat like the ghosts seen on television pictures.

MONOSCOPE TESTER

The *K1043* monoscope-tube tester built by Eastman Kodak Company is shown in Fig. 7. The monoscope tube is the lower one and its output is displayed on a 3-inch cathode-ray tube. From left to right the lower controls are as follows: Power on-off switch, aluminum or carbon current checking switch, test voltmeter selector, display-tube focus control, display-tube intensity control, monoscope vertical centering control, monoscope horizontal centering control, monoscope bias control, and the monoscope focusing anode control. This last control is used to check the monoscope best focus voltage. For all other tests the tube is operated with 290 volts on the focusing anode.

The four round knobs below the test current meter on the right side of the set are used to adjust the size and center the raster in the display tube. On the left-hand side of the set are meters to read the cathode current, first anode current and voltage, and the circuit test voltmeter.

OTHER APPLICATIONS

The first such application is a frequency multiplier. If a number of vertical stripes, n, are printed on the target, alternately aluminum, carbon, aluminum, etc., a signal will appear in the output circuit each time the electron beam scans from the aluminum to the carbon, or conversely. If there are four stripes on the target, the output frequency will be twice the input frequency. The output frequency f, is $n/2$ times the input frequency for a sawtooth scan with retrace blanked or n times the input frequency for sine-wave sweep.

By placing the stripes on an angle to the scan a phase shift can be obtained. This application might involve two monoscope tubes each of which is scanned from the same scanning supply. If a direct positioning voltage is applied to the other set of deflection plates on one tube, the output frequencies can be phase shifted any number of degrees depending upon the number of stripes on the targets.

Monoscope tubes with vertical stripes also might be used in pulse-height analyzers. The pulses being analyzed are applied to the set of plates which sweep transverse to the target stripes. Pulse height would be determined by number of output pulses obtained.

The striped target shown in Fig. 5 was used for an antenna pattern calculator. A 1-mc sweep was used and a 4-to-5-mc sine-wave output obtained. Pulse output can be obtained provided the bandpass of the output amplifier is adequate.

A pulse-forming circuit has been made utilizing a monoscope tube with a target containing a triangular opening. The triangle is placed so that the scan of one set of plates will be perpendicular to one side of the triangle and also bisect the apex of the triangle. A 60-cycle scan is applied to the other set of plates and it is positioned to scan across the triangular opening. By varying the scanning voltage, the pulse repetition rate can be varied while the pulse length can be increased by varying the position of the scan from the apex to the base of the triangle.

These applications are just a few of those possible with monoscope tubes. Targets may be of any shape or configuration and the ratio between background and target may be changed by using different target materials. It is also possible to use dual-gun tubes with common or separate targets in the same envelope.

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Pipe-Line Design for Pipe-Type Feeders

R. C. RIFENBURG
MEMBER AIEE

AN ECONOMIC DESIGN of pipe-type feeder has as small a pipe and as long a section as good engineering permits. Minimum pipe size must be large enough to insure that the top conductor, when in triangular formation, will not press against the pipe. If a clearance of 0.25 inch is calculated, using a conductor size with maximum tolerance, it is assumed that clearance is assured.

The clearance $C=D/2-1.366d+1/2(D-d)\sqrt{1-[d/(D-d)]^2}$ where C=clearance in inches; D=inside diameter of pipe in inches; and d=diameter of conductor, plus manufacturers tolerance in inches.

The effective weight of the conductors is increased because the weight of all conductors does not act normal to the pipe. Call the ratio of effective weight to weight of the conductors, the weight correction factor W_c. If K_o=the basic coefficient of friction, then the effective coefficient of friction $K=W_cK_o$.

For cradled formation $W_c=1+4/3[d/(D-d)]^2$.

For triangular formation $W_c=1/\sqrt{1-[d/(D-d)]^2}$.

For any value of D/d, W_c is less in triangular formation than in cradled formation. Experience from actual field installations has shown when the value of D/d is less than about 1.5, the conductors pull in triangular formation. Considerable savings in cost of oil and pipe are accomplished if a D/d value of this order is used.

The maximum pulling length is determined from the formula $L=T/WK$, where L=maximum straight length in feet, T=allowable tension in pounds, and K=pulling coefficient of friction. W=weight of three conductors per foot.

As K_o is determined from field data of so-called straight sections which contain minor changes in alignment, such offsets usually may be neglected in determining the equivalent length of sections containing major bends. The correction for major horizontal bends may be made by the following equation:

$$L_2=L_1 \cosh K\theta+\sqrt{L_1^2+(R/K)^2} \sinh K\theta$$

L_1=equivalent length at entrance to bend, L_2=equivalent length at exit from bend, K=the pulling coefficient of friction, θ=angle of bend in radians. R=radius of curvature in feet.

Where vertical dips are encountered, a correction may be necessary where $KL>R$. When the foregoing condition is satisfied, the tension is great enough to lift the conductors off the bottom of the pipe. No correction is necessary where $KL<R$. Side-wall pressure should be calculated for that conductor which presses hardest against pipe. This is affected by relative pipe and cable size (D/d) and arrangement of the cables (cradled or triangular).

The side-wall pressure for cradled formation $P=(3W_c-2)\,T/3R$, for triangular formation $P=W_cT/2R$.

Small-Angle Vertical Dips (See Fig. 1A)

$$L_4=L_1\epsilon^{4K\theta}+\frac{R}{K}[\epsilon^{4K\theta}-2\epsilon^{3K\theta}+2\epsilon^{2K\theta}-1],\ \theta=2d/S,\ R=S^2/4D,$$

Where $K\theta<0.10$

The second term usually may be neglected.

Large-Angle Vertical Bends—Up Hill (See Fig. 1B)

$$L_2=L_1\epsilon^{K\theta}-\frac{R_1}{1+K^2}\left[2\sin\theta-\frac{1-K^2}{K}(\epsilon^{K\theta}-\cos\theta)\right],$$

$$L_3=L_2+d\left(\frac{1}{K}\sin\theta+\cos\theta\right)$$

$$L_4+L_3\epsilon^{K\theta}+\frac{R_2}{1+K^2}\left[2\epsilon^{K\theta}\sin\theta+\frac{1-K^2}{K}(1-\epsilon^{K\theta}\cos\theta)\right]$$

Large-Angle Vertical Bends—Down Hill (See Fig. 1-C)

$$L_2=L_1\epsilon^{K\theta}+\frac{R_1}{1+K^2}\left[2\sin\theta-\frac{1-K^2}{K}(\epsilon^{K\theta}-\cos\theta)\right],$$

$$L_3=L_2-d\left(\frac{1}{K}\sin\theta-\cos\theta\right)$$

$$L_4=L_3\epsilon^{K\theta}-\frac{R_2}{1+K^2}\left[2\epsilon^{K\theta}\sin\theta+\frac{1-K^2}{K}(1-\epsilon^{K\theta}\cos\theta)\right]$$

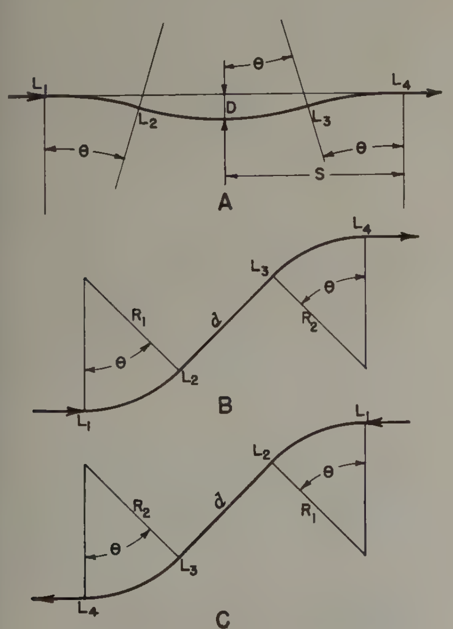

Fig. 1. Special pulling conditions

Large savings can be made in the design of pipe-type cable systems when the designing engineers become more familiar with the fundamentals affecting friction and have more confidence in the calculated pulling tensions.

Digest of paper 53-389, "Pipe-Line Design for Pipe-Type Feeders," recommended by the AIEE Committee on Insulated Conductors and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953. Published in AIEE *Power Apparatus and Systems*, December 1953, pp. 1275–88.

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Planning Carrier Facilities for a Utility System

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MEMBER AIEE

WHEN PLANNING to use power-line carrier to transmit intelligence between various stations on a power system, a logical approach to the problem is as follows.

1. Make a transmission-line map showing all the stations involved in the carrier system under consideration.

2. List all the items of intelligence to be transmitted, with terminal points. Typical items might be: telemetering station *A* generation watts, and vars stations *A* to *E*, or communication between stations *A*, *B*, and *C*.

3. Decide what kind of equipment to use. Relaying may be directional or phase comparison. Telemetering can use carrier keyed on and off, carrier modulated by keyed tone, or carrier-frequency shift. Communication can be simplex, manual or automatic, using only one frequency, or duplex, using two frequencies. Two or more functions may be combined on one channel, such as relaying and communication. Choice between these alternatives will determine the number of channel frequencies required.

4. Draw up a frequency routing chart, such as Fig. 1.

5. Lay out the coupling equipment, deciding on the number and location of coupling capacitors, line tuners, and by-passes. Traps can be put in at this stage, at each end of the relaying channels, to isolate short stubs, and to break up any loops in the power system which might form multiple paths for the carrier signals.

6. Calculate the line attenuation for each channel using any of a number of methods described.[1]

7. Estimate the line noise to be expected. Some studies[2] have been made recently on noise which give figures on which to base an estimate. These studies also show that different values of noise affect the various carrier functions used, such as the average value for comparison with a keyed carrier signal, or the quasi peak value for determining the masking effect of noise as a speech background.

8. The transmitter power, diminished by line attenuation, and compared with the noise level, gives the signal-to-noise ratio at the receiving end of the channel.

9. The design data of the equipment to be used will determine how high a signal-to-noise ratio is required for satisfactory reception of the signal.

10. Check each channel to see if the signal will be strong enough at the receiver. If not, steps can be taken to reduce the attenuation, increase the signal, or reduce the effective noise. Extra traps used to isolate low-impedance busses can prevent some loss of signal. One way to reduce the effective noise in the receiver is to use single side band for communication. This takes half the bandwidth of conventional amplitude modulation, and the more selective receiver will exclude some noise. Similarly, narrow-band frequency-shift equipment for telegraphic functions will provide good noise rejection. If necessary, a repeat point can be used in a long-haul channel over several line sections, but this will add an extra carrier frequency.

11. Allocate the channel frequencies. The permissible channel spacing can be calculated roughly by using receiver selectivity curves, determining how wide a frequency band each transmitter puts out and how much interference the receiver can tolerate.

12. Finally, having laid out the frequencies, recheck the attenuation and noise level for each channel, as the attenuation increases at higher frequencies. Fortunately, line noise studies show that the noise level is reduced at higher frequencies so the signal-to-noise ratio may not change greatly.

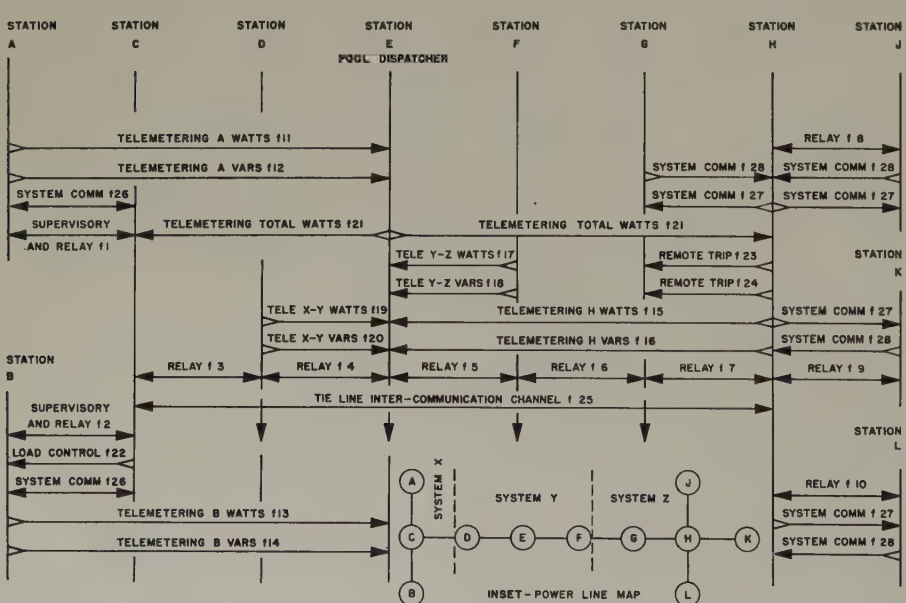

Fig. 1. Channel routing

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J. C. G. Carter is with Westinghouse Electric Corporation, Baltimore, Md.

John Findley Peters 1953 Edison Medalist

"for his contributions to the fundamentals of transformer design, his invention of the Klydonograph, his contributions to military computers, and for his broad understanding in the training of young engineers"

The Edison Medal

JAMES F. FAIRMAN
FELLOW AIEE

BY TRADITION, the chairman of the Edison Medal Committee has only a simple duty to perform on these occasions. He is expected briefly to remind the assembled company of the origin and purpose of the medal but to leave the speechmaking to others. I hasten to assure you that I am thoroughly in accord with that tradition.

Nevertheless, I believe it is in order to supplement the conventional recitation by calling your attention to the fact that the year 1954 marks the 50th anniversary of the establishment of the medal and the 75th anniversary of the incandescent lamp.

It is also appropriate to recall that Thomas Alva Edison was an active member of the Institute from the time of its founding in 1884 to his death in 1931, that he was one of the six vice-presidents chosen in the first election of Institute officers, and that the first technical paper presented at an Institute meeting dealt with the newly discovered "Edison Effect."

At the annual dinner of the Institute held on February 11, 1904, given in celebration of the 25th anniversary of the development and successful introduction of the incandescent lamp, the Edison Medal Fund and Deed of Gift were presented to the Institute and the Institute accepted the responsibility of administering the award.

Originally the medal was to be awarded annually to a student for "the best thesis on record of research on theoretical or applied electricity or magnetism." However, no awards were made on this basis and in 1908 the Deed of Gift was amended by the donors to provide for an annual award "for meritorious achievement in electrical science or electrical engineering or the electrical arts" to "some one resident in the United States of America and its Dependencies, or of the Dominion of Canada."

The first award was made in 1909 to Dr. Elihu Thomson "for meritorious achievement in electrical science, engineering and arts as exemplified in his contributions thereto during the past 30 years." Since then an award has been made in all but 2 years. This year we add the 43d name to the roll of distinguished engineers and scientists upon whom it has been the Institute's proud privilege to bestow its highest honor. The Edison Medal for 1953 is awarded to John Findley Peters "for his contributions to the fundamentals of transformer design, his invention of the Klydonograph, his contributions to military computers, and for his broad understanding in the training of young engineers."

Full texts of the presentation and acceptance addresses given at the Edison Medal ceremonies during the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954.

James F. Fairman, chairman of the Edison Medal Committee and a past president of the Institute, is with the Consolidated Edison Company of New York, Inc., New York, N. Y.

The Edison Medalist

A. C. MONTEITH
FELLOW AIEE

JOHN Findley Peters is an eminent consultant and a brilliant mathematician, but above all he is an engineer. His varied engineering contributions have ranged from improved transformer design to air-borne fire control, and more recently an ingenious liquid metal pump for atomic power plants.

Although his entire formal education was obtained in a 1-room rural grade school, a combination of a keen mind, hard work, systematic self-improvement, and determination has made him an outstanding engineer. After 20 years in engineering his technical accomplishments were so varied and impressive that Mr. Peters was named the first consulting engineer ever appointed by Westinghouse Electric Corporation. Since evening schools were not available during his youth, John Peters attained this unique position on his own. Although many successful persons are self-educated, few reach the height of John Peters in a field that ordinarily requires such extensive technical education. Today, Mr. Peters is recognized as one of the half-dozen best applied mathematicians in Westinghouse history. Although officially retired, he still is retained to solve certain difficult specialized engineering problems that have so characterized his successful technical career.

John Peters was born on September 11, 1884. He grew up on a farm near Chambersburg, Pa., where he worked immediately after completing grade school. His father wanted him to follow his own trade as a carpenter, but

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John had other ideas. He wanted to be an electrical engineer and started by reading every technical book he could borrow or buy and, at the same time, teaching himself mechanical drawing.

In 1905 Mr. Peters left the farm and somehow got a job as night electrician at the Pittsburgh Steel Company. He was able to retain this job, despite his meager technical knowledge, because he could keep the ash hoist in operation, whereas the chief electrician could not.

CAREER WITH WESTINGHOUSE

The electrical mysteries of the ash hoist were soon resolved, and John looked about for more difficult problems. He answered a Westinghouse advertisement for an armature winder, but since he could read blueprints he was hired to work on induction motors.

Then he learned of an opening in transformer engineering, and he determined to get the job. He wanted it so badly that he offered to work 3 months for nothing. Although the position normally was filled by a graduate engineer, the engineer in charge offered to give him an oral examination. A steady diet of reading and study paid off. John Peters got the job, and he earned the pay that went with it.

From then on Mr. Peters' engineering progress was sure and rapid. He began with transformer insulation and in a few years was designing power transformers as large as 4,000 and 5,000 kva, which were huge for their day. In his early days with the transformer engineering department, he heard some conversation regarding calculus so he went to the library to investigate, but found that he must learn algebra first. For John, this meant the job was longer but not necessarily harder. He learned both. During this time he developed the formulas that still are used today for the calculation of the reactance of complicated coil arrangements. He also developed the first current-limiting reactor. Prior to his work on this subject, the reactors had been wound on a concrete block. Peters' development resulted in an air-core self-supporting reactor which was very light in weight. By 1917 he was technical assistant to the manager of the transformer engineering department and in 1926 he became the first Westinghouse employee with the title of Consulting Engineer.

During the first World War he worked on and perfected means of submarine detection using the principles of the distortion of the earth's field. Just prior to and during World War II he investigated and devised systems for air-borne gun fire control and gun lead angle computers. For the period from 1939 to the present, security restrictions prevent any detailed discussion of his activity. However, he has contributed much technical knowledge to the development of such equipment as gyros, torque motors for turbine-generator governors, tie-line regulators, and a special liquid pump for the atomic power field.

Other specialized problems he analyzed and solved included bus structures for electric furnaces, special electric railway problems, and stability of a-c arcs. He invented the Klydonograph, a simple and inexpensive device for measuring lightning voltages, which won him the Franklin Institute Edward Longstreth Medal. He worked out the design of a single-phase capacitor-type induction motor that proved to be 10 years ahead of its day. He was a vital factor in designing the world's biggest homopolar generator for pipe welding. He has a total of 39 patents to his credit, only four of which are with co-inventors.

His self-acquired knowledge and an interest in mathematics always have stood him in good stead. For example, during the early stages of discussions of symmetrical components with Slepian, Fortescue, and Chubb, he made significant contributions.

Prior to his accomplishments as consulting engineer, and his work on secret Government problems, John Peters had quite a few papers in the technical press, but since that time his papers have been meager. This follows from his own personal modesty and from his philosophy that to be really effective, a consulting engineer must keep himself in the background. He has carried this philosophy almost to a fault for he has insisted that his clients take all of the credit. His published works have suffered also because he has been concerned almost exclusively since 1942 in activities regarded by the Government as classified.

This has been a relatively brief summary of the engineering career of John Peters. I think many of my older associates will agree that this story is in the true Horatio Alger tradition. And perhaps our younger associates will grant that John Peters' remarkable talent for converting meager opportunity into major achievement well might stop Horatio Alger's successor, Tom Swift.

What other technical accomplishments John Peters might have realized if he had the excellent training and help that the engineer of today takes as a matter of course, is a matter of guess work. However, for the engineer with a good formal education this question is not pertinent. The only question in regard to his potential is his ability to create opportunity, and pursue it in the words of Churchill with "blood, sweat, and tears."

WORK WITH YOUNG ENGINEERS

This formal record of obstacles overcome and honors won, however, veils rather than reveals what is probably John Peters' outstanding contribution to his company and the engineering profession. Masked by a retiring manner, shielded by modesty to the point of shyness, nevertheless John Peters has emanated during all his 47 years in engineering a kindly understanding and warm appreciation of the problems of young engineers which have won for him their silent gratitude, respect, and love.

For John Peters, possibly because he charted the pitfalls so carefully in long nights of study himself, has devoted himself to helping others to learn. Formally, he is an excellent teacher. For years he sat in the classes with the graduate students to assist and guide the discussion periods. He was noted as a lecturer in advanced design work.

But he accomplishes much more in informal instruction. His keen mind is always at the disposal of engineers with a problem and he has helped solve many problems. Beyond this, his sympathetic understanding and gracious manner often combine to solve far greater problems than the ones brought to him.

I think just one example may illustrate what I am trying

to say. Seven years ago a shy young mechanical engineer, with a firm belief that electrical engineering was made up of insoluble problems posed by the devil, joined the company. He was an introvert in the most complete sense of the word. John Peters was sensitive to the struggle this young man faced. He arranged a series of private conferences, during which he sympathetically explained the fundamentals of our branch of engineering. Under John's influence, the young man turned toward design, specializing in electromechanical equipment. Today he is one of our outstanding young engineers in this field. His work has been important in the design of complex equipment for military aircraft. But more than that, the confidence which John Peters' instruction instilled in him, has brought to light qualities which literally made him a new man. From a follower he has become a leader, not only in his profession but in his community as well. In just this one example, and there were many, many others under different circumstances, it seems to me is found the greatest contribution of John Peters to the engineering profession.

Obligations of an Engineer to His Juniors

J. F. PETERS
FELLOW AIEE

THANK YOU for this award of the Edison Medal for 1953. It is with a mingled feeling of warm appreciation and deep humility that I accept and shall always cherish this honor that the members of my Institute have so graciously conferred upon me.

There are many things I could say on this occasion, but upon looking back over my 47 years in engineering, I have decided to talk about something that always has been close to my heart. That is the obligation of the older engineers to our juniors.

One of my most enjoyable activities in Westinghouse has been to help train young engineers fresh from college. And much of the success of such a training period seems to depend upon how we as older engineers make use of our opportunity to help these young men. We all build our careers on knowledge contributed by the previous generation, so it devolves upon us to pass along to the succeeding generation our accumulated knowledge plus our personal contributions to the art. As our Past President Wickenden said, "These gifts from the past are not a private right, but a social trust."

After a lifetime of working with young engineers, both on and off the training course, there are three ways I think older engineers especially can be helpful to young men starting in our profession.

First, right at the start, let us help young engineers understand the wisdom of basing their technical career on a sound knowledge of fundamentals. With this to build on, specialization can be developed as needed. Experience reveals that seemingly the best career training pattern is like an hourglass: first, a period of broad training in fundamentals; next, a period concentrated in a specialized field; and finally, a broadening out again in preparation for responsibilities of a more extended character.

Second, treat each young engineer as an individual and encourage him in every way.

For example, in our contacts with younger men, relieve them of the misconception that they are expected to know everything about the particular subject. Encourage the young engineer to seek advice of older men experienced in their field. When they seek advice, let us go out of our way to place them at their ease. Create the proper atmosphere and climate so that they are comfortable in our presence and will speak frankly. Many young men are reluctant to ask questions for fear of appearing ridiculous. Some carry this characteristic throughout their entire life. Remember that you were once a young engineer yourself. Do not make him feel foolish. His every problem is important. Be certain that he understands our language, our terminology. Always give the young man full credit for his contributions; even lean over backwards and give him more than is due. I recall an incident several years ago of a fine young man fresh from training who had been assigned a problem involving the application of certain gyroscopic principles. After several days I asked him how he was coming along. He had accomplished nothing, because he had not understood the principles involved. He understood that if a torque were applied, a particular precession resulted. He did not understand that for the same precession, an equal torque resulted. For fear of displaying ignorance, he hesitated to seek advice. We older engineers have an obligation to prevent this type of situation.

Third, have faith in young engineers. Sometimes they accomplish astonishing results. Some of the newest areas of engineering endeavor—atomic energy, guided missiles, magnetic amplifiers—have been engineered entirely by young men. In these fields there practically are not any "old" engineers. I recall an example of how faith in young engineers paid off handsomely. A small company hired a few engineering graduates each year for their director of design to train. As a part of the training, the director of design usually handed to each trainee one of the tough problems that his seasoned engineers had failed to solve, merely explaining the result that was wanted. Because of fresh minds, unfettered viewpoints, and not being experienced enough to know that "it could not be done," the trainees have produced solutions to several of these problems.

It is important that the training of an engineer comes early in his life. A recent book by Harvey C. Lehman entitled, "Age and Achievement," analyzes the productivity and creativity of men in various lines of endeavor. Peak creativity in all of the physical and biological sciences usually comes in the early thirties. Although active until his eighties, Edison, whose memory is perpetuated by this medal, received 28 per cent of all his patents between the ages of 33 and 36.

Thus we older engineers must recognize and accept this obligation, and must appreciate that we have a precious privilege to prepare our engineering youth for the promising engineering future that lies ahead.

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A Transient Analyzer for Magnetic Amplifiers

E. J. SMITH
MEMBER AIEE

THE RESPONSE time of a magnetic amplifier is defined as the time required for the rms or rectified average value of output current or voltage to change a prescribed percentage of the difference between the corresponding initial and final steady-state values. When the magnetic characteristics of the core materials approach the rectangular *B-H* loop shape, the waveform of the output current exhibits the typical rapid rise as one core saturates at some angle α_{MA} and sinusoidal form after saturation, until the end of the half cycle. Under these conditions, the peak value of load current is independent of the average or rms value when $\alpha_{MA} \leq \pi/2$.

The operation of the transient analyzer is best described by making reference to Fig. 1. The values of control circuit voltage (E_{c1}, E_{c2}) or current corresponding to the desired initial and final steady-state values of load current or voltage are first established. The output of the magnetic amplifier then is set at the reference value (that is, 63, 90 per cent, etc., of the total change) by applying a suitable signal to the control circuit. Corresponding to the reference value of output, the magnetic amplifier saturates at some angle $\alpha_{MA}=\alpha_R$; α_R is called the reference angle.

The transient analyzer generates a voltage pulse of very short duration once every cycle. The phase of this (reference) pulse next is made to coincide with the reference angle by a manual adjustment. When the output current is less than the reference value $\alpha_{MA}>\alpha_R$, and when the output current is greater than the reference value $\alpha_{MA}\leq\alpha_R$. (Although these remarks apply only to a single-ended magnetic amplifier, the method itself can be applied to a push-pull amplifier by comparing the saturation angle of one reactor with the reference angle.) The function of the transient analyzer is to compare the angles α_{MA} and α_R every cycle and to indicate the result by generating an output pulse every cycle if $\alpha_{MA}>\alpha_R$ but no pulse if $\alpha_{MA}<\alpha_R$—for a build-up transient; and by generating a pulse every cycle if $\alpha_{MA}<\alpha_R$ but no pulse if $\alpha_{MA}>\alpha_R$—for a decay transient. The transient analyzer becomes operative only after the switch initiating the transient is thrown. Therefore, the number of pulses generated by the analyzer after the switch is thrown is equal to the number of cycles required for the magnetic amplifier output to change from the initial value to the reference value. The response time of the magnetic amplifier is obtained directly by counting the number of pulses generated by the analyzer during the transient. An electronic counter* of the conventional type was found to be a very convenient means for counting the pulses.

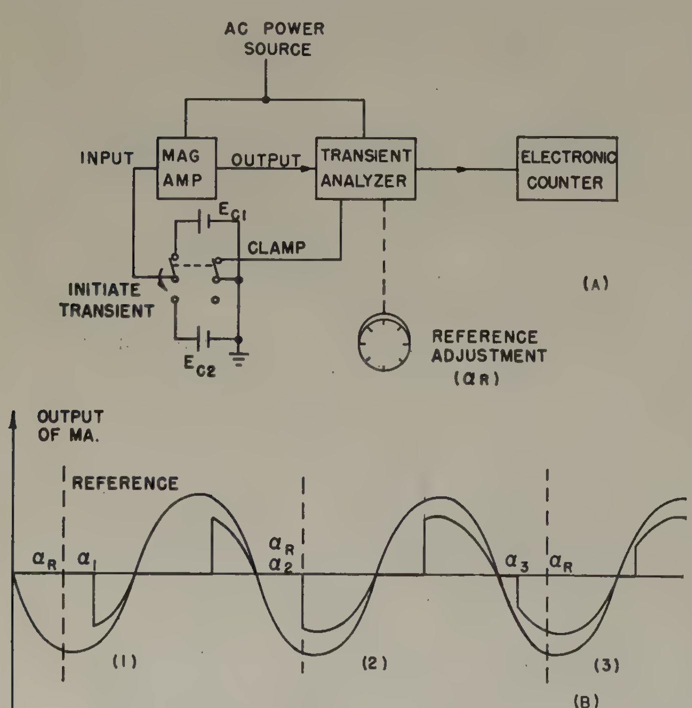

Fig. 1. Method of determination of transient response of a magnetic amplifier. (A) Arrangement of magnetic amplifier and instruments for performing measurement. (B) Typical output waveform of magnetic amplifier during a transient

The comparison of the angles α_{MA} and α_R is made during one half of the cycle (the negative half in Fig. 1). If the output of the magnetic amplifier is a-c, as shown in Fig. 1, the signal into the transient analyzer can be obtained from the load (that is, load voltage). If the signal is full-wave d-c (rectified d-c) then the signal to the transient analyzer must be taken as the voltage across one reactor winding. In any case the signal always can be taken from a winding of one reactor.

The reference pulse phase angle α_R is adjusted readily without the aid of an oscilloscope as follows: The output of the magnetic amplifier is set at the reference value by applying an appropriate steady-state control signal and observing the output with a suitable a-c or d-c meter. The transient analyzer is unclamped and the phase adjustment varied until pulses are obtained from the output terminals. (The electronic counter counts continuously as indicated by neon bulbs.) The phase adjustment is then varied (course and fine adjustments) until the output from the analyzer just ceases. The reference angle α_R now is adjusted properly. The analyzer again is clamped, the counter reset to zero, and the transient initiated by throwing the switch. At the completion of the transient, the reading of the counter is exactly equal to the response time in cycles.

Digest of paper 53-283, "A Transient Analyzer for Magnetic Amplifiers," recommended by the AIEE Committee on Magnetic Amplifiers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Published in AIEE *Communication and Electronics*, September 1953, pp. 461–5.

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* Multiple decade counters employing Eccles-Jordan flip-flop circuits as used in electronic digital computers.

Pneumatic Mechanisms for Circuit Breakers

R. C. VAN SICKLE
FELLOW AIEE

R. N. YECKLEY

A NEW AND MORE powerful unit has been added to a line of pneumatic operating mechanisms for power circuit breakers to meet the requirements of a 330-kv 25,000-mva breaker.[1] Three of the largest available mechanisms,[2] each operating a single pole, would have supplied the necessary power but required the solution of problems of synchronization and interlocking. Consequently, a new mechanism which can operate all three poles in the conventional manner was developed. It has many of the features proved to be effective and desirable in the rest of the line and can operate breakers requiring a closing effort of 160,000 inch-pounds.

Like the two earlier mechanisms in this line, the new mechanism is mechanically trip-free in all positions to make it impossible to hold the circuit breaker closed by compressed air when the trip coil is energized. Trip-free operation is obtained by connecting the pull-rod to the piston through two links which are held in an inverted toggle position by the trip-free linkage. When air pressure is in the cylinder at the time a tripping impulse is given, the trip-free linkage is released and although the piston is held by air pressure, the breaker opens freely at normal speed.

A tripping impulse, given while no air pressure is acting on the piston, releases the main latch without uncoupling the piston from the breaker. This facilitates fast reclosing because the closing circuit may be energized as early as desired in the opening stroke.

Two important features of the new mechanism are, first, a straight-line linkage to guide the piston rod and to serve as part of the latching system, and second, a high-speed latching system providing quick resetting of the triggers and short fast movements of the latches.

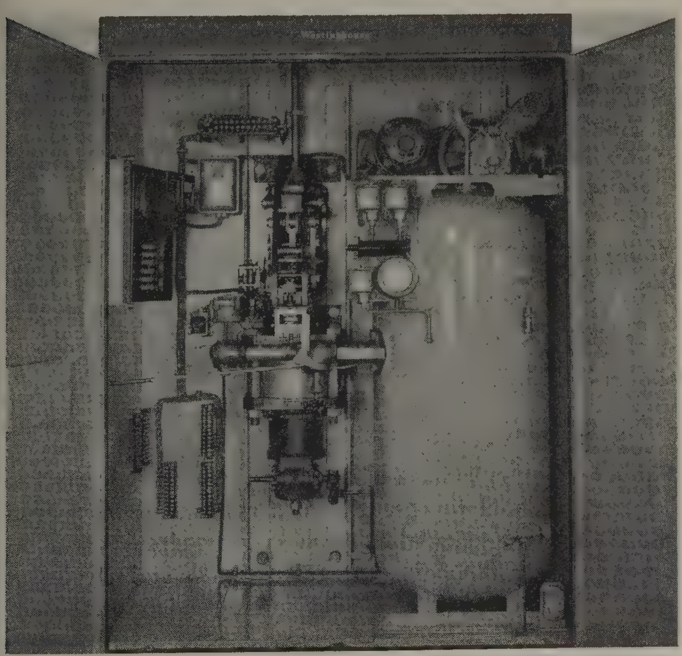

Fig. 1. Ease of inspection and maintenance are achieved by the arrangement of the apparatus in the housing

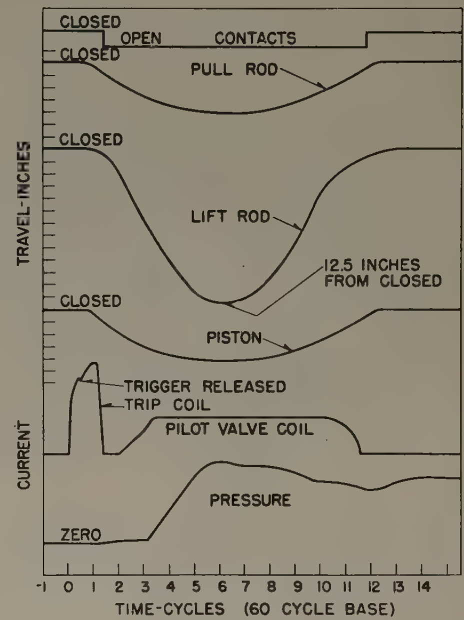

Fig. 2. A 12-cycle reclosure

Compressed air is admitted to the operating cylinder by a control valve which combines the functions of an inlet valve and an exhaust valve. Two electromagnetic pilot valves of the same type used on the other mechanisms in this line, control the air pressure acting on a piston which operates the inlet valve. The use of two pilot valves to supply only a small volume of control air produces rapid action.

The mechanism was tested with a special test frame designed to provide the load of a 3-pole breaker. Since the spring loads, fluid friction, and inertia of parts closely approximate those of the 330-kv breaker, the test results should be a good indication of future breaker performance.

This mechanism extends the line of pneumatic operating mechanisms of similar design. The others have been in regular production for over 2 years and have been supplied on most of the outdoor oil circuit breakers built by us. This mechanism makes it possible to operate breakers of the highest interrupting capacity in the simple conventional manner.

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Cathode-Ray-Tube Protractor or Synchroscope

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MEMBER AIEE

A simple resistor-capacitor circuit permitting a visual indication of phase difference between two voltages on a cathode-ray-tube screen is presented. The phase angle is related to the orientation of a straight-line image on the screen. As the angle is changed, the line image rotates through an angle equal to twice the change. An angle scale can be put on the screen with angles up to 360 degrees shown on each side of the screen so the phase angle can be read opposite either end of the line image.

THE OPERATION of this resistor-capacitor circuit may be described qualitatively as follows: Two voltages whose phase difference is to be determined are fed into a circuit. The circuit causes each voltage to trace a circle on the cathode-ray screen. Since the two circles are in opposite directions their combination is a straight line.

The circuit is shown in Fig. 1. The two signals whose phase difference is required are fed into the corners marked E_1 and E_2. The center of the circuit is a common point for output as well as input. The corners marked V_1 and V_2 are connected to the vertical and horizontal inputs of the cathode-ray tube.

Consider E_1 acting alone. The two resistor-capacitor circuits produce 45-degree phase shifts in opposite directions if $r=\omega C$ at the operating frequency. Under these circumstances V_1 and V_2 are 90 degrees apart and the trace will be a circle. Obviously a similar analysis obtains when E_2 alone is applied. Note that resistors R are very high to reduce the loading on the phase-shifting, resistor-capacitor circuit.

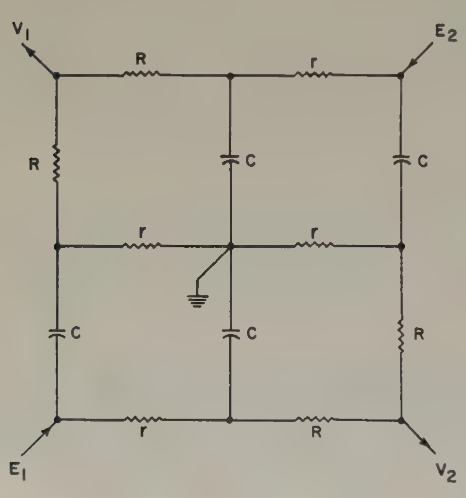

Fig. 1. Circuit diagram: E_1 and E_2 are input signals whose phase difference is to be indicated; V_1 and V_2 are output signals fed to the horizontal and vertical amplifiers of a cathode-ray oscilloscope

When both signals are applied the following explanation may be used. Let the input voltages be

$$e_1=E\cos(\omega t+\theta/2)$$

$$e_2=E\cos(\omega t-\theta/2)$$

The phase difference to be measured is θ

$$V_1=\frac{E_1}{\sqrt{2}}\angle 45+\frac{E_2}{\sqrt{2}}\angle -45$$

$$V_2=\frac{E_1}{\sqrt{2}}\angle -45+\frac{E_2}{\sqrt{2}}\angle 45$$

Assuming the magnitudes of e_1 and e_2 are equal and that the phase shift obtained is 45 degrees in each circuit, then

$$v_1=\frac{E}{\sqrt{2}}\cos(\omega t+\theta/2+45)+\frac{E}{\sqrt{2}}\cos(\omega t-\theta/2-45)$$

$$v_2=\frac{E}{\sqrt{2}}\cos(\omega t+\theta/2-45)+\frac{E}{\sqrt{2}}\cos(\omega t-\theta/2+45)$$

These will reduce to

$$v_1=\frac{2E}{\sqrt{2}}\cos\omega t\cos(\theta/2+45)$$

$$v_2=\frac{2E}{\sqrt{2}}\cos\omega t\cos(\theta/2-45)$$

This shows that the two signals supplied to the cathode-ray oscilloscope are in phase and a straight-line trace is obtained. If v_2 is supplied to the vertical and v_1 to the horizontal amplifier, and if the amplifier gains are equal, the length of the trace will be constant and its slope on the screen will be given by

$$\text{slope}=\tan\phi=\frac{\cos(\theta/2-45)}{\cos(\theta/2+45)}=\tan(\theta/2+45)$$

Therefore

$$\phi=\theta/2+45$$

$$\theta=2\phi-90$$

and the cathode-ray screen can be marked in degrees as shown in Fig. 2.

SOURCES OF ERROR

TWO OBVIOUS sources of error are frequency variations and unequal inputs. If the frequency departs from the design frequency the phase shifting circuits will not produce 45-degree shifts. In this case the scale no longer will be a uniform one. The device is intended for constant

Special article recommended for publication by the AIEE Committee on Instruments and Measurements.

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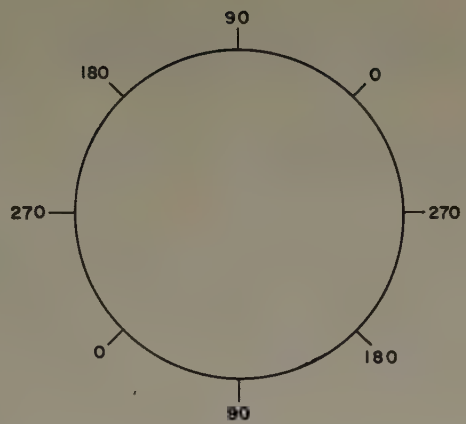

Fig. 2. Scale marking for a cathode-ray indicator. The direction of the linear trace gives the phase difference between the input signals

frequency use at 60 cycles, 400 cycles, or any other standard frequency. However, it can be made adjustable to give indications on several frequencies.

If the input signals are not equal in magnitude, the trace will become an ellipse whose major axis can be used to determine the phase angle as was done for the line segment.

EFFECT OF PHASE SHIFT

If the phase shifts in the circuits are different from 45 degrees while the two amplitudes are equal, a straight line is obtained. In this case the scale should not be marked uniformly. This effect may be analyzed by rewriting the equation for the slope of the trace as follows:

$$\tan\phi=\frac{\cos(\theta/2-\beta)}{\cos(\theta/2+\beta)}$$

where the phase shift is β instead of 45 degrees. This may be written

$$\tan\phi=\frac{\tan(\theta/2+45)+\tan(45-\beta)}{1+\tan(45-\beta)\tan(\theta/2+45)}$$

Let $\delta=(\theta/2+45-\phi)$

which indicates the deviation from a uniform scale.

$$\tan\delta=\frac{\tan(\theta/2+45)-\tan\phi}{1+\tan\phi\tan(\theta/2+45)}$$

Let $\tan(\theta/2+45)=x$

and

$$\tan(45-\beta)=k$$

then

$$\tan\delta=\frac{k(x^2-1)}{x^2+2kx+1}$$

Note that $\delta=0$ for $x=\pm1$, that is the indication is correct on the uniform scale for $\theta=0$ or ±90 degrees. The maximum value of δ for any k can be found by differentiating with respect to x. The maximum value occurs at

$$x=\frac{-1\pm\sqrt{1-k^2}}{k}$$

giving for $\tan\delta$

$$\tan\delta_M=\mp\frac{k}{\sqrt{1-k^2}}$$

Since

$$\tan\beta=r\omega C$$

$$k=\tan(45-\beta)=(1-\tan\beta)/(1+\tan\beta)$$

an error of 10 per cent in $r\omega C$ will produce a k of about 0.05

$$k=\frac{1-0.9}{1+0.9}=\frac{0.1}{1.9}=0.053$$

$$\tan\delta_M=\frac{0.053}{\sqrt{1-0.053^2}}=0.053$$

and

$$\delta_M=3°$$

UNEQUAL INPUTS

If the input signals are not equal but

$$e_1=E_1\cos(\omega t+\theta/2)$$

$$e_2=E_2\cos(\omega t-\theta/2)$$

then

$$v_1=\frac{E_1}{\sqrt{2}}\cos(\omega t+\theta/2+45)+\frac{E_2}{\sqrt{2}}\cos(\omega t-\theta/2-45)$$

$$v_2=\frac{E_1}{\sqrt{2}}\cos(\omega t+\theta/2-45)+\frac{E_2}{\sqrt{2}}\cos(\omega t-\theta/2+45)$$

Establish $x-y$ co-ordinates on the screen with the x-axis making a slope with the horizontal equal to

$$\tan\phi=\tan(45+\theta/2)$$

The y axis making a slope

$$-\cot\phi=-\cot(45+\theta/2)$$

The co-ordinates of the spot, at time t will be

$$x=v_1\cos\phi+v_2\sin\phi$$

$$y=-v_1\sin\phi+v_2\cos\phi$$

Substitution in the foregoing gives

$$x=\frac{(E_1+E_2)}{\sqrt{2}}\cos\omega t$$

$$y=\frac{(E_1-E_2)}{\sqrt{2}}\sin\omega t$$

Hence the spot traces an ellipse whose major axis coincides with the x axis and indicates the phase angle just as the straight-line image did.

CONCLUSION

This protractor should have much use since it requires only a few resistors and capacitors and a cathode-ray oscilloscope which can be found in almost all electrical laboratories.

The circuit should be designed to produce as near the correct phase shifts as possible. When the image is obtained on the screen the relative input amplitudes can be adjusted to cause the image to be a line instead of an ellipse. The presence of a harmonic such as the fifth harmonic causes little trouble if it is small in magnitude. The observable effect is that the trace will not close to a straight line. However, if such harmonics are present the amplitude of one input signal is adjusted to give optimum effect.

Flow of Energy in D-C Machines

E. I. HAWTHORNE
MEMBER AIEE

A STUDY OF THE flow of electromagnetic energy in a typical somewhat idealized d-c generator is carried out on the basis of the electromagnetic field analysis in the machine, in the hope that it will afford a better understanding of d-c machines from an analytical and educational standpoint, and that it may be of value in improving their design. Relatively few authors have considered problems in electric machinery on this basis.[1-3]

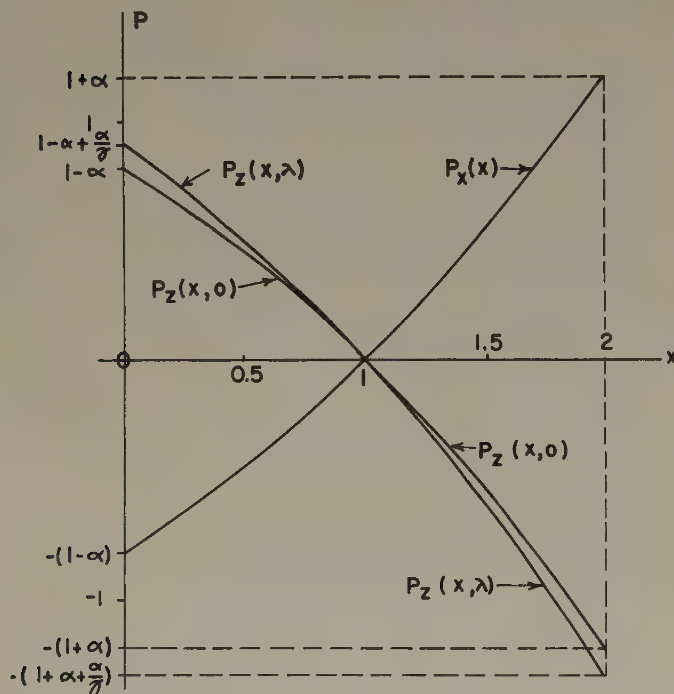

Fig. 1. Energy flow vector in the gap

$P_z(x, \lambda)=A_4(1-x)(1-\alpha+\alpha x+\alpha z)$
$P_x(x)=A_5(x-1)(1-\alpha+\alpha x)$
λ = *axial length of armature*
γ = *number of slots per pole arc*
α = *constant depending on load*
A_4, A_5 = *machine constants*

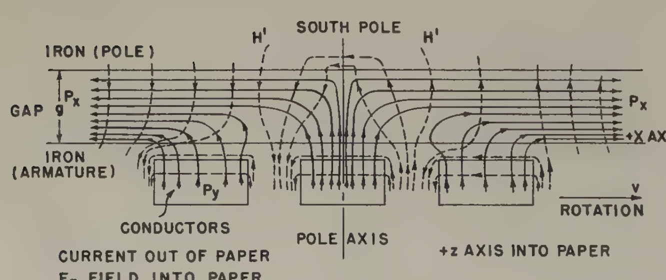

Fig. 2. Flow of energy from conductors into the gap—sectional view

H′ = field component due to armature reaction

A study of the concepts of electromagnetic energy and energy flow vectors, their validity and limitations, leads to the selection of a modified Poynting's vector as the energy flow vector. The modification consists of disregarding the components having zero divergence.

Analytical expressions may be derived for **E** and **H** fields in the gap and in or near armature conductors for the loaded machine, assumed to have a large number of conductors in its 2-layer p-pole simplex lap winding with one turn per winding element, neglecting saturation, hysteresis, and the effect of the presence of slots and teeth. For example, in the developed plane of the gap the fields are of the form:

$$E_z(x, z)=A_1(1-\alpha+\alpha x+\alpha z)$$
$$E_z(x)=A_2(1-\alpha+\alpha x)$$
$$H_r(x)=A_3(1-\alpha+\alpha x)$$

where x, z, and r are the normalized circumferential axial, and radial co-ordinates; A_1, A_2, and A_3 are constants depending on machine structure and field excitation; and α is a constant depending on load.

On the basis of these, as well as the corresponding expressions for the field in other regions of the machine, the expressions for the energy flow vector **P** are derived, omitting the interaction of the **E** field of the armature with the **H** component due to field excitation.

The flow of energy may be studied quantitatively in the gap and in the armature conductors and qualitatively in the transition region from the conductors to the gap and from the gap to the output wires, where it is determined by the fields associated with the process of commutation. A typical result of this study, the energy flow vector components in the gap, is plotted on Fig. 1. Of the two components, only the relatively smaller circumferential P_x represents a net transfer of energy out of the gap. Although P_z has a nonzero divergence, it merely serves to redistribute the flow of energy in the region under a pole arc, and contributes to the net direction of energy flow at each point in the gap. The transition region from the conductors, where the flow of energy is described by the P_y vector, to the gap is shown qualitatively on Fig. 2, where only the P_x component is indicated.

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Switchyard Grounding Mats in Rocky Soil

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B. V. CHITNIS
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ASSOCIATE MEMBER AIEE

GROUNDING OF high-voltage stations usually is accomplished by a number of driven ground rods. However, when rocky ground makes this impractical, other methods must be used such as burying a number of conductors in a criss-cross fashion at a depth of from 1 to 2 feet parallel to the surface of the earth without using any driven rods. This not only effectively grounds the electric system, but has the added advantage of controlling the voltage gradients at the surface of the earth during faults. A measure of the effectiveness of a grounding grid is given by the resistance that current encounters in flowing from the buried grid conductors into ground. The allowable value of the resistance to ground will depend upon the single line-to-ground fault current at the switchyard concerned. Various design factors of the grounding grid influence its resistance to ground.

An expression for the resistance to ground of such grounding grid can be found from a study of the emission of electric flux from a similar configuration of conductors having isolated charges. The resistance to ground R of an electrode system near the surface of the earth, and the capacitance C of the same electrode system, and its image with respect to the surface of the earth are related by the equation

$$R=\frac{\rho}{2\pi}\frac{1}{C}$$

where ρ is the resistivity of earth. The problem of finding the resistance to ground of a grounding grid resolves itself into that of determining the capacitance of the grid and its image in a medium of unity dielectric constant. The method of subareas, first used by Maxwell to calculate the capacitance of a square, is applicable to this problem and was used in this investigation.

The actual grid will cover a certain area which will be criss-crossed by the grid wires. The density of the mesh will depend upon the separation between the wires. If the separation is increased, all that will be left in the limit will be a square of four wires which enclose the area formerly occupied by the grid. The capacitance of these four conductors and their image will give an upper limit for the resistance to ground of the grid. If the number of meshes of the grid is increased by placing additional conductors within the area, the resistance to ground will decrease until the spacing between the grid wires becomes zero, so that the grounding system has become a square plate. This will establish the lower limit on the resistance to ground which could be obtained for the actual grid. The results of the computations are shown in Fig. 1 for square grids of various numbers of meshes. The resistance decreases very rapidly upon adding the first few meshes to the square created by the boundary conductors. The addition of subsequent meshes beyond a certain point does little to reduce further the resistance to ground.

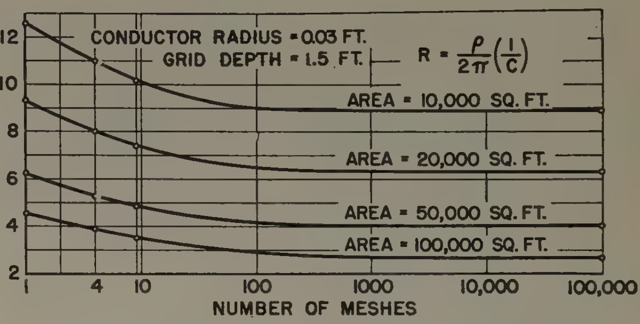

Fig. 1. Influence of the number of meshes on the resistance

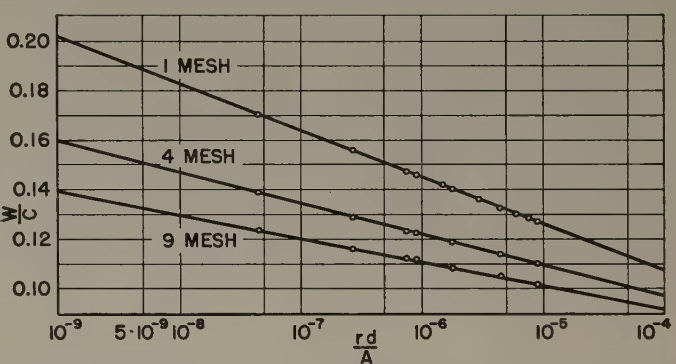

Fig. 2. Resistance to ground: universal curve for grounding grid

The curves in Fig. 1 are for a particular conductor radius of $r = 0.03$ foot and a distance between the grid and its image of $d=3$ feet. The effect of changes in these parameters is shown in a universal curve, Fig. 2, in which a wide range of values for rd/A has been covered. The area occupied by the grid is represented by A, and the width by W.

The general conclusions drawn from this study are

1. The area enclosed by the grid should be as large as possible. The number of meshes need not exceed more than are required to ground each piece of equipment and station structure.
2. The diameter of the conductors does not affect materially the grounding resistance; it is determined by thermal and mechanical rather than electrical considerations.
3. The depth to which the grid is buried is determined essentially by the nature of the soil. The grid should be buried as deeply as possible with due regard to the expense for excavation.

Digest of paper 53-239, "Grounding Grids for High-Voltage Stations," recommended by the AIEE Committee on Substations and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Published in AIEE *Power Apparatus and Systems*, August, 1953, pp. 799–810.

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Analogue Solution of Heat Conduction Problems

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THE DIFFERENTIAL EQUATIONS of heat conduction become exceedingly complex for all but the most elementary systems, and in the practical case recourse must be had to numerical or experimental solutions. One such experimental method is to make use of the similarity which exists between the equations of heat flow and the equations of the flow of a unidirectional current in a mesh consisting of resistance and capacitance. In both cases, the quantity of flow depends upon the magnitude of the potential in the direction of flow and upon the conductivity of the medium supporting conduction. In both cases, also, there is a transfer of energy. However, in the thermal system, the thermal conductivity is a function of the magnitude of the applied temperature, while in the electric system, the electrical conductivity is normally independent of the voltage provided, that is, interest is confined to true conductors, and the physical system is ventilated. There is a correspondence too, between the thermal energy stored in the medium and the electrostatic energy stored in a capacitance, for the quantity of heat or electricity stored is simply equal to the product of capacitance (thermal or electrical) and potential.

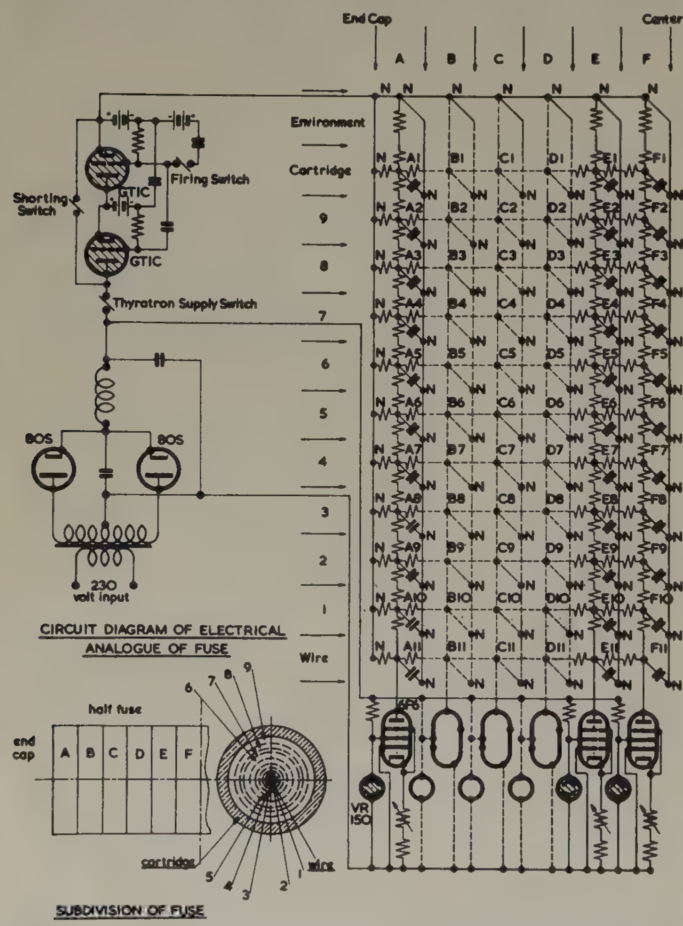

Figure 1. The circuit used to represent the thermal system of a simple cartridge fuse

These principles have been used to construct a network analogue of the thermal system of a simple cartridge fuse which consists of a copper wire surrounded by quartz powder and contained in a porcelain cartridge. The ends of the cartridge are closed by metal terminals, and the outer surface loses heat by free convection and radiation. The practical circuit of the analogue and the correspondence between the various sections of the fuse and the network are shown in Figure 1. Since the thermal field is symmetrical about a plane normal to the cylindrical axis and through the center of the fuse only one-half of the fuse need be represented by the network; also, the electric network can be a 2-dimensional mesh provided the components are graded to compensate for the change in total parameters as the radius increases.

Errors arise in the electrical representation of the thermal system from several sources. These are

1. The resistivity of the fuse wire is represented by an average value.
2. The continuous thermal system is represented by a number of lumped circuits.
3. The analogue current magnitude has to be set up, and the tolerances on the values of the analogue components kept as small as possible.
4. The analogue voltage response is measured by an oscilloscope.
5. The specific heat, thermal conductivity and density of the wire, filling material and cartridge, and the coefficient of heat transfer from the outer surface of the cartridge are represented by average values.
6. The end terminals of the system are considered as infinite planes held at the ambient temperature.

Of these, error 1 causes a time error of 15.5 per cent, the recorded fusing times being smaller than the actual times and a temperature distribution error of up to 3 per cent. Error 2 is not significant provided a measuring loop contains at least four sections; errors 3 and 4 produce time errors of up to ±5 per cent and temperature distribution errors of ±2 per cent. Error 5 is not significant in comparison with error 1 and it is believed that error 6 also may be neglected for normal applications.

Digest of paper 53-411, "An Analysis of an Analogue Solution Applied to the Heat Conduction Problem in a Cartridge Fuse," recommended by the AIEE Committees on Computing Devices and Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

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The work described was performed in the Electrical Engineering Department of Queen Mary College. The authors would like to acknowledge the advice and encouragement given by Professor W. J. John and by Dr. H. Tropper and W. B. Diamond. Dr. Carne would like to thank the Governors of Queen Mary College and the Senate of the University of London for financial support.

65,000-Kvar High-Power Laboratory Capacitor Bank for Variety of Switching Tests

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This new capacitor bank, which can be operated up to 65,000 kvar, has widened considerably the range of testing possible in the high-power laboratory. In this way it furnishes facilities in line with the electrical industry's rapid growth.

A NEW large capacitor bank with a nominal rating of 21,600 reactive kilovolt-amperes (kvar) but capable of being operated at 65,000 kvar for short periods of time without overstressing the individual units has been installed in the a-c high-power laboratory at East Pittsburgh, Pa. This installation has expanded greatly the range, both voltage- and current-wise, of capacitor switching tests made to verify circuit breaker performance when handling the charging current to long transmission lines, high-voltage underground cable, or large banks of static capacitors. Also, by making available a considerable amount of shunt capacitance it has increased the flexibility of control over circuit conditions such as the rate of rise of recovery voltage on short-circuit interrupting tests. This expansion of laboratory facilities is the result of the high rate of growth of the electrical industry with its ever-increasing and exacting demands upon the ratings and performance levels required of switchgear.

DESCRIPTION OF BANK

The new high-voltage capacitor bank recently installed in the a-c high-power laboratory[1] and shown in Fig. 1 consists of 864 individual capacitor units each having a continuous rating of 25 kvar, 2,400 volts, 10.4 amperes, and 11.5 microfarads ($X_c=230$ ohms). This gives a total rating for the full bank of 21,600 kvar. However, for laboratory use only these capacitors can be operated at 173 per cent of rated voltage for approximately 10 cycles. Since the kvar is directly proportional to the square of the voltage, the 10-cycle rating of the complete bank is 65,000 kvar.

The basic stacking unit consists of a group of 18 individually fused capacitor units in a structural steel frame, see Fig. 2. Each stacking unit may be connected in series, or parallel with the other units depending on the voltage to be applied to the bank and the test current desired. There are 48 stacking units giving a total of 48 times 18 or 864 capacitors.

The complete bank consists of 12 frames of 4 stacking units each, see Fig. 1. Each frame is insulated for a voltage of 198 kv line-to-ground for a momentary application not to exceed 10 cycles.

When making single-phase tests, the bank can be set up for any combination from 1 to 48 stacking units in series. The capacitors within the stacking units can be arranged in parallel combinations of 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, or 18.

The use of knife switches and the provision of suitable bus bars within the structure of each stacking unit makes it possible for two men to make any change in these combinations within 5 minutes.

When testing 3 phase, the bank is divided into three legs connected Y or delta. This is shown in Fig. 3 with one block equal to two basic stacking units. Combinations of 1 to 16 of these units in series per leg can be obtained, together with parallel combinations of 2 to 18 individual capacitors, the same as the single-phase combinations.

When testing 3-phase switching one group of capacitors against another, the bank is divided into two groups of three legs each connected Y or delta (Fig. 4) with combinations of 1 to 8 stacking units in series per leg with parallel combinations the same as the foregoing single-phase combinations.

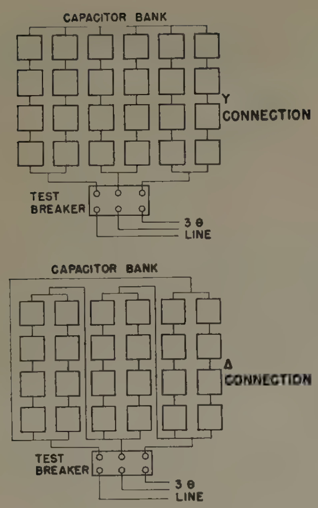
Each stacking unit has two rows of nine capacitors each.

Fig. 1. New 65,000-kvar capacitor bank recently installed in a-c high-power laboratory at East Pittsburgh

Fig. 2. Close-up end view of one frame consisting of four stacking units

Full text of paper **54-139**, "Flexible High-Power Laboratory Capacitor Bank for Variety of Switching Tests to 65,000 Kvar," recommended by the AIEE Committee on Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1954.

R. E. Friedrich and **D. J. Burns** are both with the Westinghouse Electric Corporation, East Pittsburgh, Pa.



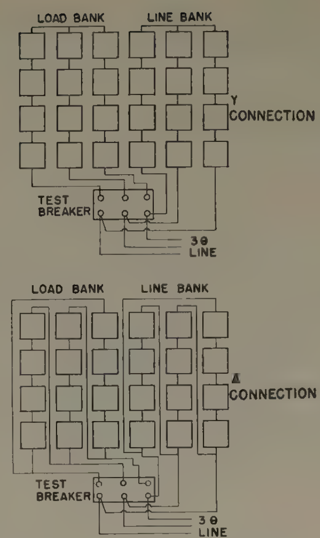


Fig. 3 (left) and Fig. 4 (right). Block schematics showing relative positions of test circuit breaker and capacitor bank for 3-phase testing. Each unit represents two stacking units. (Left) banks connected Y or delta. (Right) tests simulate the switching of line and load banks connected either Y or delta

Directly above each row there is a horizontal bus divided into two sections, see Fig. 5. On one side there are two capacitors connected to one section of the bus and seven capacitors connected to the other section. On the other side of the unit there are three capacitors connected to one section and six connected to the other. On the outer end of each section of the horizontal bus there is mounted a single-pole double-throw knife switch which can be used to short-circuit out to the frame the section of capacitors that are not being used in the circuit. The switch can be thrown to a third horizontal bus running through the center of the rack. This connects the section of capacitors into the circuit. The current path for one frame of four stacking units is shown in Fig. 6. The switching is done with a 7-foot hook stick, see Fig. 1, making it possible to switch the required number of capacitors into the circuit in a matter of minutes.

The stacking units have individual outdoor fuseholders mounted on the horizontal bus above each of the capacitors, see Fig. 2. A conducting leaf spring serves to connect the end of each fuse refill with its capacitor unit. One end of this spring is attached solidly to the capacitor so that the spring extends horizontally. Then the outer end of the leaf is flexed upwards and connected to the end of the fuse refill, thus putting tension on the latter. If the fuse element blows, this spring then pulls out the refill and returns to a horizontal position. An air gap thus is inserted into the circuit and no voltage remains across the fuseholder. The horizontal position of the spring after this ejection also serves as a visual indication of fuse operation in addition to removing a defective capacitor from the circuit.

The bank is protected from overvoltage surges by a parallel adjustable rod gap with a series resistance to limit the current through the gap if flashover occurs.

Referring to Fig. 7, at location *A* a bedplate has been installed for mounting large high-voltage test circuit breakers. At point *B* a test rail car may be located for tests involving the switching of split banks both single and 3 phase. These positions are located close to the bank to make it possible to connect the test breaker to the capacitors with the shortest possible leads thus keeping inductance to a minimum.

A group of three type *V* disconnect switches is located at one end of the bank. These are used to discharge the capacitors to permit making circuit changes with safety. A high-voltage closing switch is available for use in series with the test breaker for energizing the capacitors just prior to the opening of the test breaker. Very satisfactory records of the voltage on the capacitor bank and across the breaker terminals are obtained by the use of special amplifier circuits to eliminate the saturating effect upon potential transformers of the charge left on the capacitor bank.

SIMULATING HIGH-VOLTAGE TRANSMISSION-LINE SWITCHING[2]

The exceptionally high available capacitance of this new bank affords opportunities for verifying the switching ability of high-voltage circuit breakers at voltage ratings and lengths of line equal to or in excess of the rapidly increasing demands of the electrical industry. A complete single pole of a 330-kv breaker can be tested at currents equivalent to a length of line of over 300 miles[3] and a 230-kv pole unit at currents corresponding to approximately 450 miles. Because traveling wave phenomena accompany the switching of transmission lines and complicate the voltage transients on the breaker during the occurrence of multiple restriking, the equivalent circuit for laboratory testing would involve much more than a single bank of lumped capacitance. However, since the modern-design high-voltage oil circuit breakers with multiflow interrupters are either restrike-free or involve only very infrequent single restrikes, the representation of line capacitance by a bank of grouped capacitors is valid for determining for a given breaker the probability of restrike-free performance.

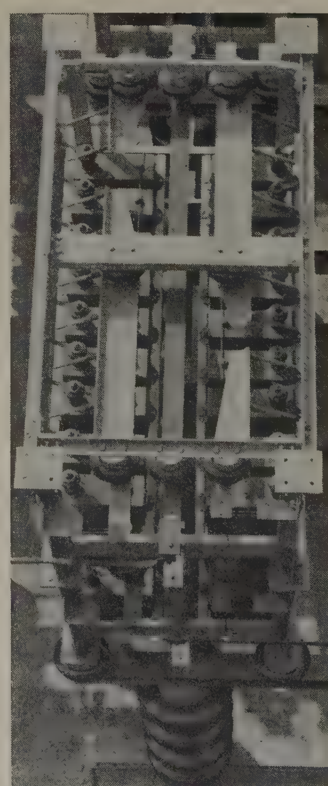


Fig. 5. Top view of stacking unit showing split bus sections, central bus, and fusing of individual capacitors

Prior to the installation of the new bank it was necessary to resort to the use of special test circuits and procedures in an attempt to obtain line switching data for most of the

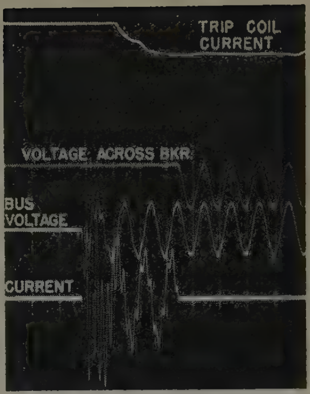
high-voltage breakers. Primarily this involved: (*a*) the testing of one-half of a pole unit at one-half the normal line to ground voltage, and (*b*) the use of series resistance approximately equal to the critical damping value.

(*a*). Fractional pole unit testing at the corresponding reduced voltage assumes an equal distribution of restored voltage across the several portions of the pole unit. The new large capacitor bank permits full pole tests at full line-to-ground voltage and eliminates the need of considering questions of voltage division among the individual breaks.

(*b*). The use of series resistance was intended to eliminate voltage surges accompanying either the closing of the test circuit or restriking during interruption, thus allowing the use of fewer individual capacitors in series and a larger number in parallel to afford higher values of current. The damping effect upon the voltage is indicated in Figs. 8 and 9 showing two oscillograms of tests without and with series resistance.

A point to consider in the use of series resistance of a value sufficient to damp the voltage oscillations of the circuit critically is that a phase shift is introduced so that the current no longer leads the voltage by nearly 90 degrees, but may lead by 70 or 80 degrees. As a result, the charge remaining on the bank after the current zero of interruption is less than that corresponding to the peak value of line-ground voltage and the recovery voltage appears across the breaker contacts at a rate considerably greater than that of a $(1-\cos\theta)$ function as indicated in Figs. 10 and 11. This deviation from the desired waveform is particularly pronounced at the higher currents where the ratio of R/X is high and where the protection afforded by the resistor is necessary. Since the effect of the change of rate of rise of recovery voltage on breaker performance cannot always be evaluated, it is advantageous to have the new and larger capacitor bank which makes the use of a critical damping resistance unnecessary and thus removes this uncertainty.

The increased capacity of the new bank also makes it possible to test a breaker pole unit with sufficient recovery voltage to compensate for the effect of interphase capacitive coupling involved in a 3-phase switching operation. Fig. 12 is a simplified schematic diagram of a 3-phase transmission line showing the line-to-ground and interphase capacitances. In Fig. 13, the voltage E_c trapped on the line side of the first pole unit to interrupt rises during the period of time until the other two phases interrupt, here assumed to be 1/4 cycle later. The value to which this voltage E_c rises lies between lines E_{c1} and E_{c2} of Fig. 13. E_{c1} corresponds to the voltage left on the line assuming no interphase capacitance and E_{c2} to the voltage only considering interphase capacitance. Analysis of the phenomena indicates that for most lines the recovery voltage appearing across the first pole to interrupt reaches a value somewhat greater than twice line to ground. The recovery voltage rises, therefore, following a complex function (curve *A* of Fig. 14). It can be approximated closely in the laboratory by the $(1-\cos\theta)$ function corresponding to a test at 120 per cent of normal line-to-ground voltage (curve *B*). For example, a single-phase test on one pole unit of a 230-kv breaker should be made at $1.2\times 230/\sqrt{3}=158$ kv. The recovery voltage then would be 316 kv or 2.4 times the normal line-to-ground voltage of 132 kv. A single-phase test at 158 kv undamped on a full pole unit was impossible with the previous capacitor bank but with the new bank a current of approximately 325 amperes is obtainable equivalent to 370 miles of line.



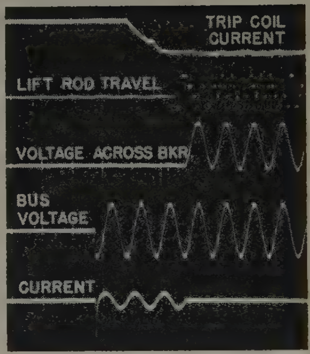


Fig. 8 (top) and Fig. 9 (bottom). Oscillograms of capacitor switching tests to eliminate voltage surges. (Top) without resistance; (Bottom) with resistance

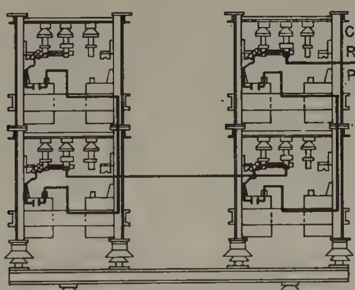


Fig. 6. End view of one frame showing current path through a portion of the capacitors

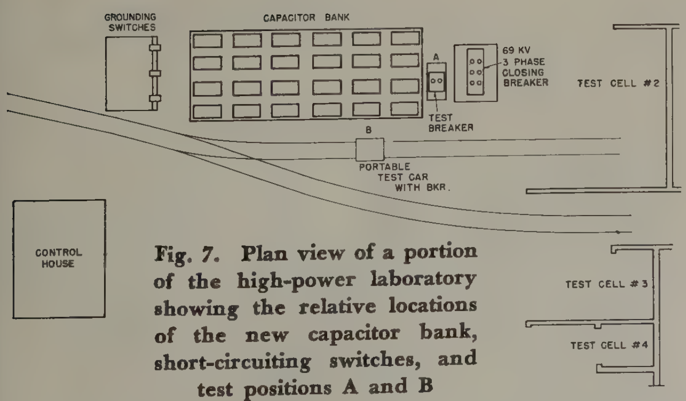


Fig. 7. Plan view of a portion of the high-power laboratory showing the relative locations of the new capacitor bank, short-circuiting switches, and test positions A and B

SIMULATING OF CABLE SWITCHING

TRANSIENT ANALYZER STUDIES indicate that traveling wave effects are negligible in cables up to 10 miles or more in length so that cables can be considered as

lumped capacitances during switching tests. The size of the new capacitor bank is such as to be more than adequate to verify breaker ability to switch cable circuits which at the present time are operating at voltages up to 138 kv.

STATIC CAPACITOR BANK SWITCHING

THE USE OF shunt capacitor banks on high-voltage transmission systems to obtain improved voltage regulation at the load, see Fig. 15, is a practice which is becoming widespread.[4,5] Most such installations are on lines up to 115 kv and it is at these voltages that the laboratory bank finds its greatest use. The very low value of the inductance of the connections between physically close banks in actual installations introduces a high frequency in the current surge accompanying certain switching combinations of the line and load bank breakers. To duplicate this condition in the laboratory the test breaker can be located near the center of the new bank mounted on a rail car as already described and shown in Fig. 7 and used to switch between two halves of the bank thus providing the very low inductance between breaker and banks needed to duplicate this condition.

Fig. 4 shows the test connections and physical arrangement of bank and breaker to provide 3-phase switching tests of bank against bank for both Y and delta connections. Breakers rated up to 46 kv can be tested readily under these conditions.

MISCELLANEOUS USES OF CAPACITOR BANK

BY CONNECTING a portion or all of the new bank across the terminals of the test breaker sufficient capacitance is available to alter considerably the frequency of the recovery voltage transient on breakers rated up to 330 kv. Thus it is possible to modify the rate of rise of the recovery voltage accompanying the interruption of fault currents in the laboratory. Such a procedure affords a good picture of how the breaker can be expected to perform under varying and actual rates of rise on the user's system. Additional tests without the parallel capacitance provides a good factor of safety.[6]

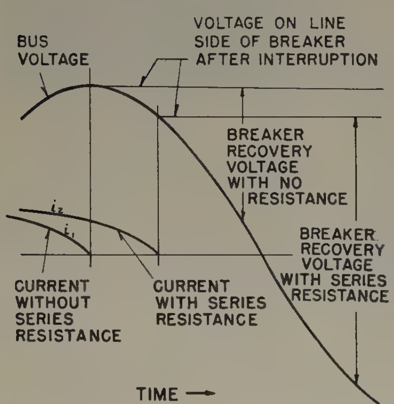


Fig. 10. Diagram showing the effect of resistance in series with the capacitor bank upon the recovery voltage appearing across the test circuit-breaker terminals

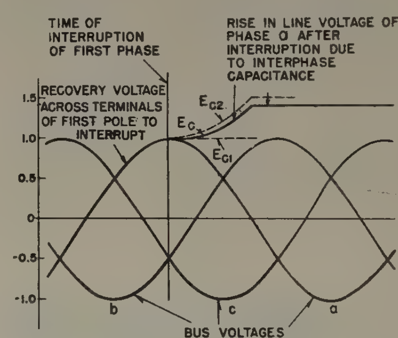


Fig. 13. Diagram of 3-phase line switching operation illustrating the rise in potential of the line on the first phase to interrupt and its effect upon the circuit breaker recovery voltage

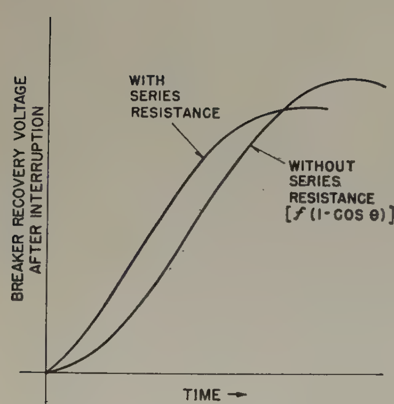


Fig. 11. Comparison of the test circuit-breaker recovery voltages accompanying tests with and without resistance in series with the capacitor bank

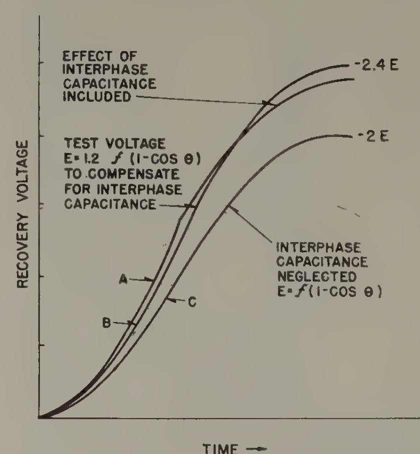


Fig. 14. The recovery voltages appearing across the breaker terminals are compared for the several conditions of Fig. 13

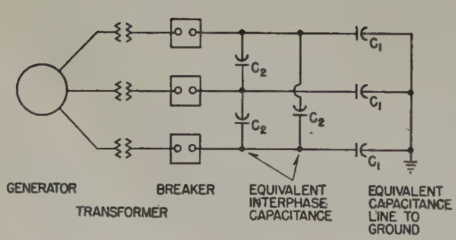


Fig. 12. Simplified schematic of a 3-phase higher-voltage transmission line showing equivalent line-to-ground and interphase capacitances

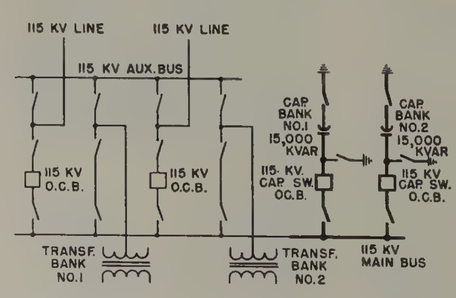


Fig. 15. Single-line diagram of a typical installation of shunt capacitor banks on a high-voltage transmission line

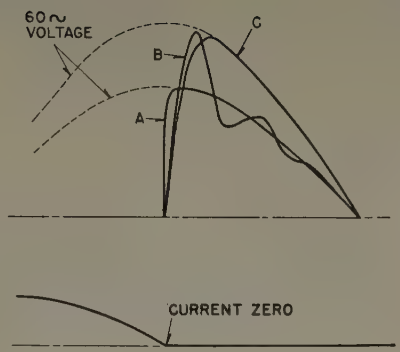


Fig. 16. Comparison of effect in recovery voltage transient of resistance and capacitance across terminals of circuit breaker: A—Damped recovery transient on 44-kv laboratory test circuit involving 1/2 pole unit of 230-kv 10,000-mva oil circuit breaker with parallel resistance; B—Recovery transient on 44-kv laboratory test circuit involving 1/2 pole unit of 230-kv 10,000-mva oil circuit breaker with parallel capacitance; C—Characteristic recovery voltage appearing across 1/2 pole unit of 230-kv 10,000-mva oil circuit breaker operating on user's system

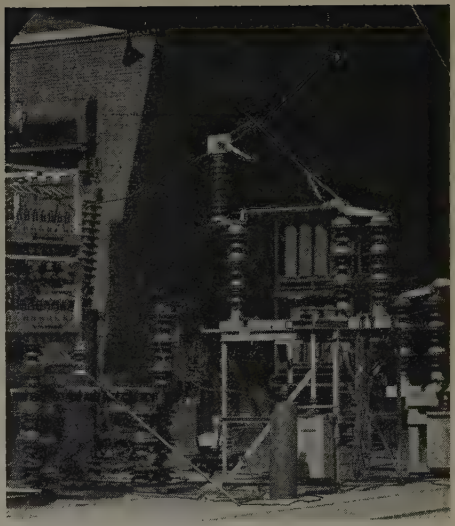


Fig. 17. New load break disconnect switch equipped with gas-filled interrupter unit life tested with several thousand capacitor switching operations

Because of their damping effect resistors sometimes are used in parallel with the breaker contacts to reduce the rate of rise of the recovery voltage transient (curve *A* of Fig. 16). However, as shown in the example of Fig. 16 the use of capacitance for this purpose has the additional advantage of allowing the transient voltage to overshoot by a considerable amount the peak value of the 60-cycle voltage (curve *B*). Thus, it is possible, for example, to verify a 230-kv 10,000,000-kva breaker by testing one-half a pole unit at 44 kv and the laboratory maximum output of 25,000 amperes instead of the proportionate 66 kv, and relying upon the voltage overshoot to reach or exceed that to be expected under field conditions (curve *C*), namely 66 kv with the reduced rate of rise of recovery voltage.

The very considerable capacity of the new bank affords a range of currents sufficient to take a great number of closely spaced repetitive life tests without overworking or shortening the useful life of the capacitor units. Several thousand tests were made on a new load break disconnect switch with a gas-filled interrupting chamber, see Fig. 17.

CONCLUSIONS

The new capacitor bank described in this article, capable of being operated to 65,000 kvar, has broadened greatly the range of testing which may be done in the high-power laboratory. The method of grouping the individual units affords considerable flexibility of connection so that single- and 3-phase tests can be made, simulating line and cable switching, and also the switching of load and line capacitor banks used for voltage regulation connected either Y or delta. Allowance can be made on single-phase testing for the interphase capacitive coupling of long lines. The bank which is capable of being operated at 198 kv line-to-ground permits the testing on charging currents of a full pole unit of a 330-kv breaker. Also more precise control of the rate of rise of recovery voltage on short-circuit interrupting tests is now possible. Thus the new 65,000-kvar capacitor bank in the high-power laboratory provides testing facilities in keeping with the rapid growth of the electrical industry.

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Construction Begun on New Electrical Engineering Center

Construction has begun on Cornell University's new electrical engineering center. Completion of the building will take about a year. A teaching and research center, it will house Cornell's School of Electrical Engineering, the oldest of such schools. Specially designed laboratories will provide advanced facilities for instruction and research in communications, illumination, servomechanisms, electric machinery, and other phases of electronics and power.

Unusual features will include a large soundproof, echo-free chamber for work in acoustics and audio research. Other specialized laboratories have been designed for work with basic and industrial electronics, vacuum tubes, transistors, television, and radar.

A computing section will house the McIlroy pipe-line network analyzer developed at Cornell and a Westinghouse electric network analyzer for studying power systems.

The building also will contain a 200-seat auditorium and a student-faculty lounge, plus classrooms, offices, shops, and storerooms. The roof will be used for research with antennas and other equipment.

Designing a New 330-Kv Outdoor Air Switch

A. H. POWELL
MEMBER AIEE

THE USE of 330 kv as a system voltage involves many problems, and the experimental equipment and line installation by the American Gas and Electric Service Corporation at their Tidd Plant resulted in new ideas and data for solutions to corona, insulation, line loss, protection, and other problems.

Previous investigation has shown that a system operating at 330 kv can be protected by suitable lightning arresters and grounding so as to give good service with porcelain insulation having impulse withstand levels of approximately 1,300 kv. In view of this, new 330-kv air switches were developed to use stacks of insulators having eight units, although they are to be installed initially with 1,300-kv 7-unit stacks of insulators.

Preliminary work was carried out using single stacks of 7- and 8-insulator units. They were mounted on a steel channel supporting structure, with a 3-inch *IPS* piece of aluminum and bus support, or a switch contact with and without corona rings, at the top of the stack. All impulse tests were made with a $1^1/_2$x40-microsecond wave.

The tests showed that basically, the negative impulse is always higher than the positive. An 8-unit stack of insulators with a 4-foot-long conductor on top resulted in a withstand of 1,757 kv negative and 1,640 kv positive. Adding grading rings to the bottom of the stack generally did not affect the negative value but did decrease the positive; an undesirable situation. Rods gave an effect just opposite to the rings. The negative values were reduced considerably but the positive was reduced a lesser amount. Other tests were made with 24-inch-diameter corona shields made of $1^1/_4$-inch *IPS* aluminum on each side of a switch contact. The withstand values were less than 2 per cent lower, respectively, than with the conductor even though the gap distance was reduced approximately 6 per cent.

To get data on switch clear break distance, switch contact and hinge parts were placed on 8-unit insulator stacks, and the contact end was moved relative to the hinge to vary the open gap. With the hinge grounded, switch open, and contact impulsed, the critical gap was 110 inches. With the contact grounded and the hinge impulsed, a critical clear break or open gap of 120 inches was necessary. This was arbitrarily increased 10 per cent to 132 inches and the sample subjected to 25 impulses of 2,100 kv. All flashovers with a $1^1/_2$x40-microsecond wave occurred across the stack; none across the gap. However use of grading posts to co-ordinate the stack and gap more accurately was found to permit a reduction in switch size and may indicate a desirable approach for future higher-voltage switches.

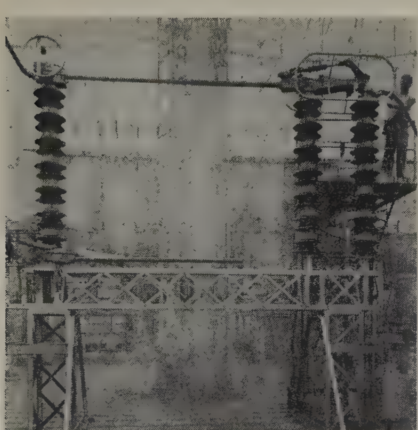

Fig. 1. 330-kv 1,600-ampere type RF Horn Gap Switch, with 7-unit insulator stacks (1,300-kv impulse withstand) and ground switch, during setup for magnetizing current interruption tests

A number of factors, including the tests described, finally led to the selection of 132 inches (11 feet) as the proper open gap distance for the new 330-kv switch that was to co-ordinate with insulator stacks having eight insulator units. It was developed with a continuous current rating of 1,600 amperes, momentary rating of 70,000 amperes to co-ordinate with 25,000-megavolt-ampere power breakers, provision for a ground switch, to be either motor or manually operated and have no visible corona at 210 kv (leg voltage of 330 kv plus 10 per cent). It was necessary also that the switch open the magnetizing current of a 3-phase 100,000-kva grounded-neutral transformer.

Fig. 1 shows the first production switch, during setup in the General Electric Company Switchgear Development Laboratory for tests. The switch blade is completely counterbalanced. The operating crank moves the blade through a link which, combined with a cam and roller built into the blade hinge support, provides for movement of the blade in a vertical plane without rotation, but upon reaching the blade stop on the contact, produces 45° rotation of the blade into contact. There are no flexible braids but rather, line-type contacts at the hinge as well as the contact. The copper current-carrying members are backed by insulated stainless steel compression springs and the jaw contact fingers are formed so the passage of current during short circuit increases the pressure. An associated ground switch operates essentially the same as the main blade.

Full-scale momentary tests were made on a complete switch. A special supporting frame was used for the two unevenly spaced return conductors which simulated the force that would result in normal service. With the switch set up as shown in Fig. 1, magnetizing currents of 3.7 to 12.5 amperes at voltages of 190 to 216 kv were interrupted easily, with the tip of the blade open approximately 3 feet. A comprehensive set of dielectric tests were made on the completely assembled switch.

Digest of paper 54-33, "Dielectric and Other Problems in the Design of a New 330-Kv Outdoor Air Switch," recommended by the AIEE Committee on Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1954.

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Pipe-Type Cable Installation Techniques

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IN 1932 THE type of feeder now known as "high-pressure pipe-type cable" was first installed in the United States and was followed by a few similar installations in the years prior to World War II. The successful experience record on these pipe cable feeders resulted in a large swing to this type of transmission circuit when the termination of World War II made materials available for the tremendous utility system expansion which was required.

This rapid growth has seen changes and improvements in installation techniques, and these discussed herein are based on experiences with pipe-type cable in Detroit, Mich., and New York, N.Y.

Pulling lengths have been materially increased as compared to early installations. In the 1,500,000-circular-mil 138-kv class, the early lengths on the order of 1,500 feet have been increased to the present average of approximately 3,000 feet.

Two sections, having a length of 6,750 feet each, of this conductor size were successfully pulled under the Narrows of New York Harbor in 1952. The introduction into the pipe, in advance of pulling, of a considerable quantity of oil reduced the effective weight of the cables by "flotation" in the oil and reduced the pulling tension.

Some factors which limit the allowable section lengths are abrupt changes of grade, offsets in the pipe line, and the existence and position of bends with respect to the cable feed-in point.

A critical point occurs at the end of the pipe where the cable emerges and where a change in direction of the cable as it leaves the pipe must be made. Excessive sidewall pressures may develop at this point, and one means of preventing damage is the use of a half section of steel tubing which acts like a shoehorn to prevent the cable from rubbing on the pipe end or guide pulley.

Study must be given in each installation to the relation between cable size and pipe size if jamming of the cables during pulling is to be prevented. In Detroit a special separator adaptor at the mouth of the pipe has been developed to insure that the cables enter the pipe in the same triangular formation throughout the entire pulling operation.

The rate of installation of the pipes can be improved if planning is such as to permit welders to work steadily with minimum shifting of their equipment. This has led to the practice of joining 40-foot sections in place in the field rather than preparing "double headers" in advance.

The use of bell and spigot joints is favored in Detroit, since no chill rings are required and a smooth entrance is made into each pipe length. The direction of cable pulling is determined in advance.

Welds are tested individually in New York by means of "pigs" which permit the application of a 500-pound internal nitrogen pressure in the weld area. The presence of bubbles in an external water bath would reveal the existence of leaks. An improved type of pig has been developed resulting in a reduction in the weight of the device and improving the safety of its use by preventing pressure build-up in the pipe behind the pig.

X-ray testing of welds may be found to be advantageous under particular conditions.

In Detroit an external testing device has been developed which consists of a chamber which can be positioned over the weld and inflated to 900 pounds per square inch (psi). This pressure is checked for a 5-minute period and any loss in pressure would indicate a leaking weld. For testing long lengths of pipe line, test pressures have been reduced in Detroit from 500 to 350 psi. In both New York and Detroit the use of bulk nitrogen delivered in 40,000-cubic-foot trailers has minimized the need for the use of air compressors.

Manholes are predried both in New York and in Detroit before splicing operations are begun. In addition, air conditioning the manholes to maintain a low relative humidity during splicing is practiced by Detroit. It is recognized that moisture must be kept out of the cable system, and this will become of even greater importance if pipe feeders in the voltage class of 230 kv or above are to be installed and used.

Cable pulling methods have not changed appreciably, although minor improvements in devices such as the development of flexible nightcaps and the use of flexible feeding tubes have simplified operations. Positioning of the winch immediately over the manhole has resulted in a saving of space occupied in the street.

The taping of joints has been simplified in New York when kraft paper is used by permitting the splicers to obtain the final design slope of the cable reinforcement by stepping the hand-applied outer jacket.

In Detroit where the pipe feeders use nitrogen gas as the pressure medium, stop joints are not used. In New York where all of the feeders are oil-filled, stop joints are installed at intervals of approximately one mile. A new design of stop feature has been developed which has a number of desirable features.

During normal operation, there is no pressure exerted against the cable insulation as is the case with the usual type of sealing gland, and the joint may be caused to close automatically in the event of loss of pressure in the pipe line, if desired. Inflated tires seal annular oil ports around the individual cables when the stop feature closes.

Digest of paper 54-73, "Pipe-Type Cable Installation Techniques," recommended by the AIEE Committee on Insulated Conductors and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1954.

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Impulse Voltage Characteristics of Circuit Breakers

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INSULATION CO-ORDINATION is a major consideration in the cost and design of a complete electric power system and of all individual pieces of apparatus. Basic impulse levels have been standardized so that apparatus and protective equipment can be co-ordinated. These levels are measured by withstands on specified test waves. Depending upon the type of protective device and the physical arrangement of the station, short-time voltage surges having crests above the basic impulse level may be present and will require special consideration to insure insulation co-ordination.

Insulation strength varies with time and for usual insulation it increases as the time of voltage application is decreased. This variation is shown by a volt–time curve which is a plot of the crest voltage applied versus the time to disruptive discharge. To prevent breakdown, it is necessary that the applied voltage crest be below the lowest point on the volt–time curve for the particular test wave. To protect against voltages which exceed this value, a protective device must be used which has a volt–time curve which lies below that of the equipment and thus will be the first to discharge.

In the discussion of a basic impulse level for 330-kv systems, the characteristics of tank-type oil circuit breakers on short-time voltage surges were needed. Published data have shown that for standard $1^1/_2$x40-microsecond full-wave impulse tests on tank-type oil circuit breakers the discharge will occur externally as a bushing flashover. The basic reason for this is the inherently high ratio of $1^1/_2$x40-microsecond wave voltages to 60-cycle crest voltages required to puncture oil. This impulse ratio of oil is in the order of 2 to 5 as compared with 1.0 to 1.5 for air. Thus, based on present insulation standards, a tank-type oil circuit breaker which will pass the 60-cycle 1-minute withstand test satisfactorily will have no difficulty within the breaker tank on a standard impulse test.

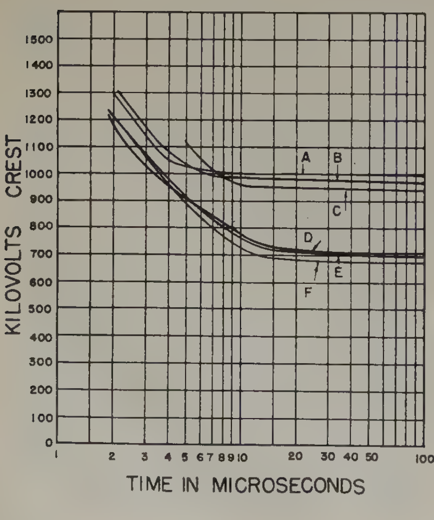

Fig. 1. Volt–time curves for a 138-kv tank-type oil circuit breaker and for its bushings separately for a $1^1/_2$x40-microsecond wave

It has been assumed that a tank-type oil circuit breaker similarily would withstand high overvoltage surges for short times without internal breakdowns. However, as far as is known, there are no published data of tests made to prove the validity of this conclusion.

To determine the volt–time characteristics of tank-type oil circuit breakers, a modern 138-kv 3,500-megavolt-ampere breaker was tested on a standard $1^1/_2$x40-microsecond wave. The voltage was increased in small steps until flashovers were obtained which approached crest breakdown. The results of these tests are shown in Figure 1. Tests were made with both positive and negative polarity and with the breaker in the open and closed positions. With a positive polarity applied, the curve for the breaker closed (*D*) is very similar to that with it open (*E*). With a negative polarity applied, the curve for the breaker open (*B*) is again quite similar to that with it closed (*C*) except at the upper end where some divergence is shown. The negative values were appreciably higher than those for the positive tests. The tests were made up to voltages of approximately twice the basic impulse insulation level. There were no breakdowns within the breaker tank on any tests.

Also shown in Fig. 1 are volt–time curves which are representative of this type of bushing when tested alone. Both the negative curve (*A*) and the positive curve (*F*) are essentially the same as those of the same polarity made on the complete breaker.

The results of these tests are of importance to the field of insulation co-ordination since they indicate the following new conclusions:

1. The volt–time curve of a tank-type oil circuit breaker for a $1^1/_2$x40-microsecond impulse wave is essentially the same as that of the bushing alone.
2. With a $1^1/_2$x40-microsecond test wave, short-time overvoltages will not cause breakdown within the breaker tank. This conclusion is based upon present standards for insulation level withstand tests.
3. The withstand voltage for the breaker for a $1^1/_2$x40-microsecond wave which is chopped by a protective device in 2 microseconds or less is approximately 1.7 times the basic impulse insulation level.

Some surge protection must be applied, of course, to oil circuit breakers. These initial tests indicate that the volt–time curves for the bushings can be used to determine the proper and most economical level of insulation co-ordination for the breaker itself.

Digest of paper 53-347, "Short-Time Impulse Voltage Characteristics of Tank-Type Oil Circuit Breakers," recommended by the AIEE Committee on Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Pacific General Meeting, Vancouver, British Columbia, Canada, September 1–4, 1953. Published in AIEE *Power Apparatus and Systems*, October 1953, pp. 998–1000.

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Electron Tube Performance in Some Typical Military Environments

D. W. SHARP

The performance of electron tubes in various types of military equipment in both land-based fixed communications and ship-borne equipments is discussed after summarizing the methods of collecting data.

THE DATA presented herein were chosen from the mass of information assembled by Aeronautical Radio, Inc. (ARINC) through field surveillance of equipments in actual military use. This surveillance activity is being conducted for all three military services as a part of their tube improvement program, under a contract issued through the Navy Department. The surveillance program is now in progress at various bases selected by the military to provide a good cross section of all electronic tube applications in all types of environment.

These applications include communications equipments ranging in complexity from the small handy-talkie to high-powered fixed installations; air-borne and ground radar; sonar; gunfire and missile control systems; IFF, ECM, and others. Among the types of environment represented are man-pack sets, wheeled and track vehicles, propeller-driven aircraft, jet fighters and bombers, ships of the U. S. Navy, and fixed-station land-based equipments. It is felt that this presents a fairly complete coverage of military tube applications as they exist today.

Before beginning the discussion of the data, the methods of collecting tubes and data in the field and compiling the information for analysis will be outlined briefly.

METHODS OF COLLECTING DATA

WHEN a base has been selected by the military for field surveillance, an ARINC field office is set up at that base. The military electronics personnel are instructed to do two things: first, to place all failed or rejected tubes in a printed envelope provided by ARINC; and, second, to fill in the information requested on the envelope. This information includes the unit of equipment and number of the socket from which the tube was removed, the tube type, the reason for removal, and pertinent facts concerning the condition of the equipment at the time of removal. If the removed tube is of a type that is too large for insertion into the envelope, the envelope is attached to the outside of the tube.

The tubes and envelopes are deposited in containers conveniently placed at repair stations from which they are collected periodically by ARINC field representatives. All tubes thus collected are marked with a serial number identifying the tube and the week of collection. Receiving-type tubes are tested on a Hickok *539A* tube tester, and the results of the test, together with the information on the collection envelope, are recorded on a weekly tabulation sheet.

Once a week, the field office ships the collected tubes and the tabulation sheets to ARINC headquarters in Washington. Here, a sample of the tubes is retested on laboratory tube testers. This is done as a means of providing additional information and, also, as a continuing check on the accuracy of the field testers. An International Business Machines (IBM) card is punched on each tube, making a permanent record of the tube's history, and the tubes then are forwarded to Cornell University for further testing. The results of this final testing are made available to ARINC and included in the permanent record on each tube.

Tubes collected in the manner just described are referred to as "semicontrolled." This term is used to indicate that complete information is not available on the tubes—that is, ARINC does not know the hours of service, nor the exact condition at installation, other than the fact that the tubes were new when installed. To obtain these types of information, what are referred to as "controlled tests" are conducted. The distinguishing feature of a controlled test is that the tubes are installed by, or under the supervision of, ARINC personnel, and complete information is obtained. Each tube is individually numbered by means of a decal, the tube is pretested, and the test readings are recorded. Operation time is kept on each tube until it fails, or until the test is terminated. Failed and terminated tubes are retested and the results recorded. Complete data on each of these tubes are punched on IBM cards.

The following information on tube performance is from two of the military bases in this surveillance program. One is a land-based communications station; the other is a naval base.

LAND-BASED FIXED COMMUNICATIONS SYSTEM

AT THE first base to be discussed, the equipment includes high-powered transmitters, receivers, microwave relay installations, and terminal equipment such as Teletype receiving and transmitting units. The equipments are all rack-mounted, with space and weight considerations secondary to accessibility and ease of testing. For the most part, they are located in air-conditioned rooms, so that high ambient room temperatures do not occur. The equipment operates 24 hours per day except

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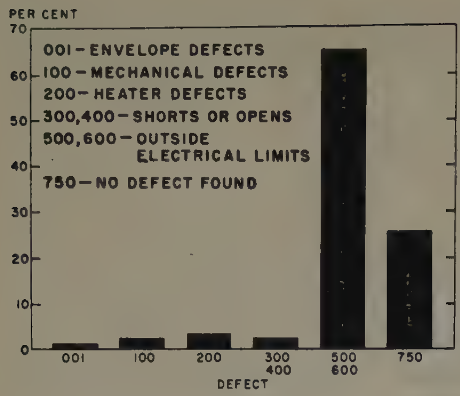


Fig. 1. Defect distribution of tubes removed from land-based communications equipment

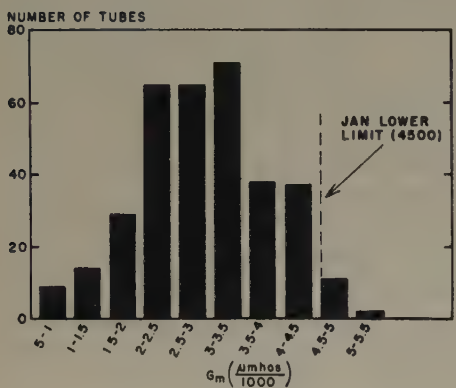


Fig. 2. G_m distribution of 12AT7 removals from land-based Teletype equipment

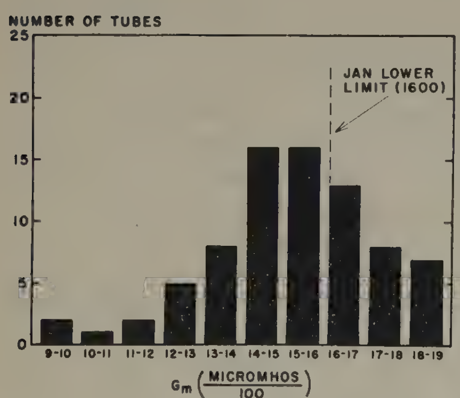


Fig. 3. G_m distribution of 6SK7 removals from land-based communication receivers

for periodic maintenance; therefore, cycling is not a factor in tube wear-out. The power source is well regulated, eliminating surges to the units. This base was selected for discussion because it was believed that the electronic applications would parallel computer application more closely than those at other surveillance bases.

Maintenance procedures at this base differ somewhat for different equipments and are based on experience with the equipment performance.

Generally speaking, equipments are tested in the racks where they normally operate. The receivers, for the most part, are given a daily performance check. If no trouble is indicated, no further handling of the units occurs except for a quarterly or semiannual testing of all tubes, at which time tubes are replaced if they fall below a predetermined G_m value for amplifier types and an emission value for diodes. The periodic testing is performed as often as experience indicates is desirable, but no more often than necessary to hold emergency failures of equipment to a minimum.

Maintenance on the Teletype terminal equipment differs in that performance is tested frequently at reduced power supply voltage. If the units function normally at the reduced voltage, no other test is made and tubes are not tested or replaced on any periodic basis.

It is felt that tubes in these equipments are given excellent chances of survival. Factors usually considered detrimental to tube life—such as vibration and shock, cycling, handling and frequent testing of tubes on tube testers, high operating bulb temperatures, temporary or permanent overvoltages, and compact weight-saving construction—either are held to a minimum or are nonexistent.

A sample of 2,343 tubes returned from this base have a defect distribution as shown in Fig. 1. The defect findings on which the distribution is based were obtained, in the case of receiving-type tubes, by testing each tube on the ARINC field tester; for transmitting types, the defect findings represent the judgment of the military maintenance personnel. The tubes represented here do not include any of the military improved types manufactured under Navy and Air Force programs.

The first bar on the left side of Fig. 1 represents tubes with broken glass. It is not known that this glass breakage occurred during normal operation; some of it may have occurred after the tubes were removed from the equipment and before retesting in the laboratories.

The second bar represents visually observed mechanical failures. These faults include loose plate caps, loose or broken bases, and broken welds and supports within the tube.

The third bar represents heater and filament failures, exclusive of heater-cathode short circuits.

The fourth bar indicates the percentage of returns having short-circuited or open elements within the tube, including heater-cathode short circuits.

These first four categories may be grouped under the broad general classification of mechanical failures. This type of failure is considered catastrophic—that is, the tube functions up to a point, then fails abruptly. From the base in question, the total of these mechanical faults represents only 9 per cent of the aggregate returns.

The fifth bar, as can be seen, accounts for a majority of the tube returns. The tubes in this defect category are considered electrical failures, meaning that they failed to meet the lower-limit test on some parameter by which tubes are judged. Low transconductance is the predominant defect of the tubes in this group, but low emisson, excessive grid current, and low leakage resistance are also present. These failures are considered due to wear-out or old age, and should be predictable, since they are not the sudden-death type of failure. An adequate preventive maintenance plan would remove these tubes from service before an emergency break in operation occurs.

The last bar represents those tube returns which show no defect on retest, that is, tubes still within manufacturing specification limits on the parameters tested. There are

several reasons why tube returns may fall in this category: (1) circuitry which, either due to design or faulty components, will not accept tubes that are still within limits; (2) use of a tube tester that does not test some parameter important to particular circuits; (3) precautionary removals by the maintenance man due to elusive troubles within a circuit or related circuits; (4) wholesale tube replacements during major overhaul or renovation of equipments; and (5) disagreement in findings between tube tester equipments at the military base and those at this laboratory regarding tubes which were removed as falling below specified limits.

It is believed that at the base under discussion, the fifth reason is the predominant factor in the "no-defect" returns. When a sample of the tubes in this category were retested on the basis of Joint Army-Navy (JAN) specifications, they were found to cluster at, or very near, the lower transconductance limit. A distribution of the measured G_m values for type *12AT7* tubes in the combined electrical and "no-defect" categories is presented in Fig. 2. Only the G_m value of the low section is shown. A similar distribution is shown for the *6SK7* in Fig. 3. Plots of other tube types indicate similar results. The distributions in Figs. 2 and 3 indicate that the tubes in the electrical and "no-defect" categories are actually the same type of removal and that any cure for the electrical type of failures automatically would eliminate most of the removals in the other category.

If the returns are grouped into the two general categories of mechanical failures and electrical deterioration failures, the percentages for this military base are 9 per cent mechanical and 91 per cent electrical. Improvement programs now in progress on military tubes would reduce the number of mechanical failures. Data from one Navy base show a reduction in this type of failure greater than four to one for one tube type, as a result of the use of improved types.

More interesting than the mechanical failures are the 91 per cent of the tubes which fall in the electrical defect category. In the present state of the art, it seems safe to say that tubes in operation will fail eventually due to cathode deterioration, deposits on the micas, cathode interface formation, or other changes within the tube. It should be mentioned that tube manufacturers are devoting much effort to the task of providing longer-life tubes. Some improved types incorporate slotted micas, coated stems, and more passive cathodes. At this time life data are not available on these improved types.

If the loss in G_m that would result from a gradual degradation of the cathode emitting material is considered, the results might be something like the theoretical plot shown in Fig. 4. Here a normal distribution around the center value of JAN specification limits as the starting point of a lot of new tubes has been assumed. This would vary from lot to lot. It also has been assumed that the G_m distribution will drift downward with time, and the spread between upper and lower values will increase. If a continuous check were made on these tubes in operation and if tubes were removed as soon as the G_m fell below the lower specification limit, a plot of the frequency of tube removal would be similar to the curve shown in the lower part of the figure. This is a skewed distribution, since the original assumption was that the G_m slope was accompanied by a spread in upper and lower values.

For individual tube types, the slope of the G_m drift would be different, but, once established, would allow a fairly valid prediction of tube usage rates in environments where tubes are allowed to wear out normally.

Fig. 5 is a plot of the average G_m decay of a group of tubes from the life test rack. It is apparent that there is an almost linear decay with time, out to 6,000 hours. The lower line on the chart represents similar data supplied by a manufacturer on another tube type. In neither case is there any evidence of increased rate of fall during the period of the test.

How well the actual tube removal rates fit this theoretical curve is indicated in Fig. 6, which shows the quantity of *6BA6* tubes removed in consecutive 500-hour periods out to 10,000 hours. At first glance, the distribution does not appear to fit the expected curve very well. For example, there are too many returns in the first 2,000 hours. This suggests that the tubes should be classified

Fig. 4. Theoretical plot of expected tube removals based on G_m deterioration with time

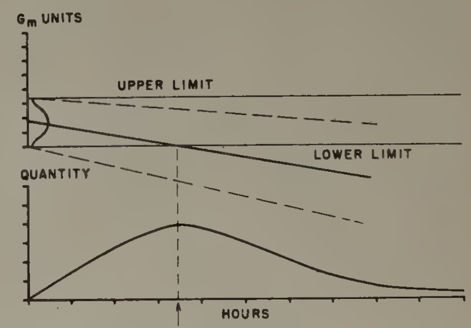


Fig. 5. Average G_m decay with time, based on laboratory life tests of two tube types

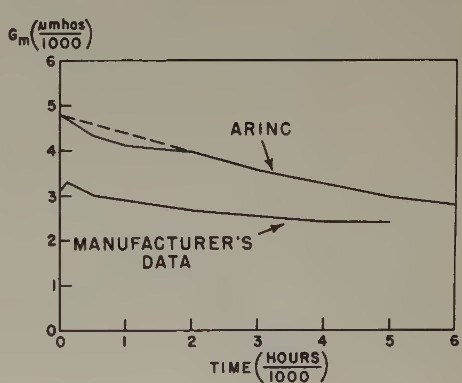
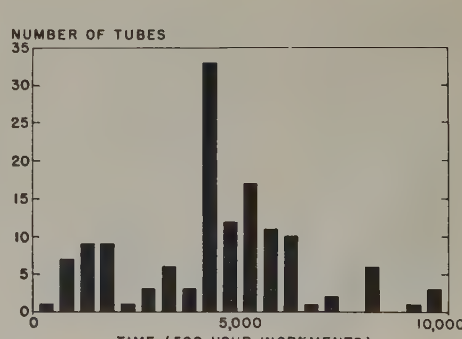


Fig. 6. 6BA6 removals from land-based receivers by 500-hour periods



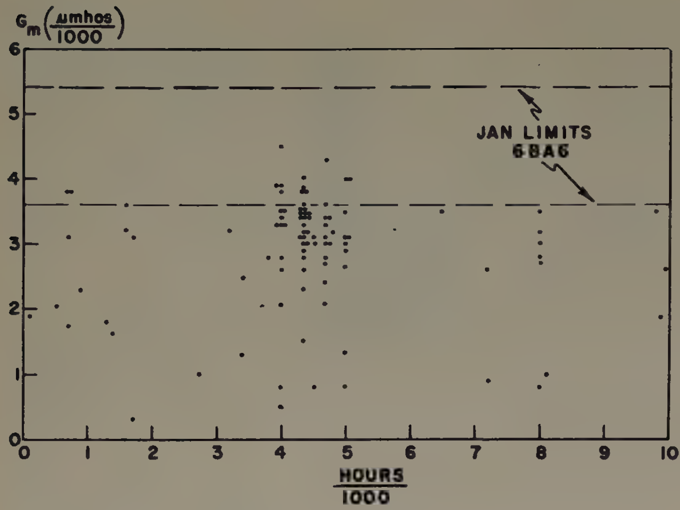


Fig. 7. 6BA6 removals from land-based receivers: G_m vs. hours of operation

into two groups on the basis of cause of failure. The basic reasons for this group of early failures is not known at this time.

Another deviation from the expected curve is in the period between 2,000 and 4,000 hours. Here the number of returns is low. It should be remembered, however, that the tubes are not under continuous test and many of them drop considerably below the lower limit before being removed. This is illustrated in Fig. 7, which shows the actual G_m values of removed tubes vs. hours to removal. It will be noted that considerable spread exists in the G_m values at the time the periodic maintenance check is made. If the tubes with low G_m had been removed at the time they actually dropped below limits, the histogram in Fig. 6 more nearly would follow the theoretical curve. An estimated slope for G_m for the *6BA6* in this particular environment and application would be 450 micromhos per 1,000 hours, or a 10-per-cent drop in the first 1,000 hours.

A histogram for the *6SK7* in similar use is shown in Fig. 8. Here, as before, the peak in removals is too pronounced, and the quantities of removals prior to that time are low. Again, these deviations are due to the interval of time between tests on the tubes. For the *6SK7*, an estimated slope of G_m vs. time would be 70 micromhos per 1,000 hours. This amounts to a 3.5-per-cent drop in the first 1,000 hours.

It should be pointed out that only with tubes of a single

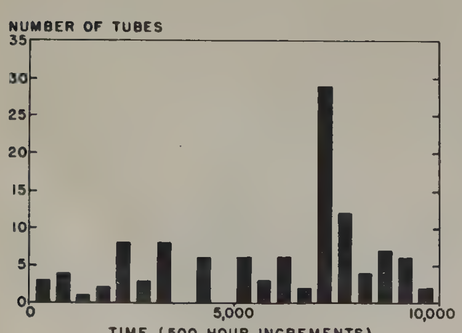


Fig. 8. 6SK7 removals from land-based receivers by 500-hour periods

type used in similar applications would this rise in failures show up at a particular time. Should many tube types or many applications of a single tube type be considered, there would be different slopes for G_m in each case, and the combined effect would be to level out the sharp rise seen in Fig. 8.

Preliminary data on the *12AT7* tube indicate a transconductance drop in excess of 700 micromhos per 1,000 hours. For this tube type, the pattern of removals vs. time is complicated by the fact that malfunction of only one side of the tube is enough to cause removal of the entire tube. The effect is to remove a good section from the test because the other section is bad. This spreads out the expected increase in removals indicated in the theoretical curve shown in Fig. 4. The expected average time to removal is therefore more difficult to predict.

A controlled test had been installed in Teletype terminal equipment to compare performance of the *12AT7* and an improved version of this type, the *6201*. Since a majority of the tubes are still in service, final conclusions cannot be drawn. The test has been in operation 4,400 hours, and out of 33 tubes of the *12AT7* type installed, 11 have been returned as failures, against a return of 4 out of 36 for the *6201*. Very limited data indicate the decay of G_m with time in the *6201* to be about one-half as great as the 700 micromhos per 1,000 hours observed in the case of the *12AT7*.

In the same equipment there are also 31 tubes of the *6SN7GT* type in operation, for the purpose of studying the build-up of cathode interface resistance. This group of tubes contains about equal quantities of cathodes of three types, that is, active, normal, and passive. Previous returns indicate that 95 per cent of all *6SN7GT* tubes had measurable interface resistance. After 4,400 hours, none of the controlled tubes has failed; information is not yet available as to which type of cathode will give the best performance.

Cornell University measurements on a sample of 942 tubes of 14 types from the base under discussion show that 82 per cent have measurable interface resistance. Considering that 9 per cent of the tubes from this base have mechanical defects, it would appear that approximately 91 per cent of the electrical-type failures have some interface resistance.

Fig. 9 represents a plot of measured interface resistance vs. the measured G_m of some *12AT7* tube returns. Each dot represents the two measurements on one section of a *12AT7*. The solid curve is a calculation of G_m vs. unby-passed resistance in the cathode of a tube. For this calculation, an original G_m was chosen from the center value of a group of new *12AT7*s. New tubes tested were not distributed around bogie, and a lower value was used for this calculation. The tube returns should have been distributed on both sides of the solid curve if the only cause of low transconductance was the effect of unby-passed resistance in the cathode circuit. Since the readings on the tubes place most of them below the line, it is assumed that some other deterioration of the cathode also has occurred. The nature of the resistance is such that it varies with cathode current; thus, the measured value may

decrease considerably during test if appreciable cathode current is used. This accounts for the larger values of interface resistance plotted above the calculated line.

SHIP-BORNE EQUIPMENTS

THE SECOND group of tube returns which will be discussed are from ship-borne equipments and, thus, from a different type of environment than those previously considered in this article. As would be expected, the characteristics of these returns are also different.

The equipments in this case represent many types of application, such as communications, radar, sonar, and others. For the most part, they are rack- or console-mounted, and subject to only limited vibration and shock. Shock mounts are provided where shock is thought to be a factor. A system of periodic preventive maintenance is in effect, although the frequency of this maintenance varies from equipment to equipment and from ship to ship. In general, daily operational checks are made on equipments which are in more or less constant use—that is, 500 to 700 hours per month—and monthly tube testing is performed when practical. Wholesale tube testing usually occurs prior to the start of an extended cruise.

It would seem that tube testing plays a more important role in the maintenance of complex equipments than of relatively simple units, such as audio amplifiers and communication receivers. Where troubles tend to be elusive, as in the case of complex equipment, greater significance is attached to the minimum readings indicated on tube testers. This may result in frequent tube testing and, consequently, more handling.

The defect distribution of tube returns from the ship-borne equipments is shown in Fig. 10. Comparison with the similar distribution for land-based equipments which was presented in Fig. 1 shows an increase in all types of mechanical failures. Whereas 9 per cent of the returns distributed in Fig. 1 were mechanical-type failures, Fig. 10 shows a total of 22 per cent in this classification. The greatest difference is in the fourth bar from the left, representing short-circuited or open tubes, which accounts for 12 per cent of all returns, compared to 2 per cent in Fig. 1. This difference may be due to factors other than shock and vibration during operation. For example, where there is insufficient storage space for new tube stocks aboard ship, the tubes in some cases are removed from their cartons and stored in sliding drawers. Also, increased handling or testing for short circuits by the standard procedure of rapping the bulb probably increases the number of tube returns.

The fifth bar in Fig. 10, representing the tubes testing out of electrical limits, is considerably lower than in the distribution for the land-based equipments. In this chart, 44 per cent of the tubes fall in this category, compared to 63 per cent in Fig. 1. Each of these percentages, of course, is relative to the other defect percentages for that particular base. A reduction in the electrical failure group usually indicates that tube removals, on the average, have less operating time. Application, environment, and maintenance procedures combine to reject the tubes for reasons other than normal wear-out. This condition is reflected

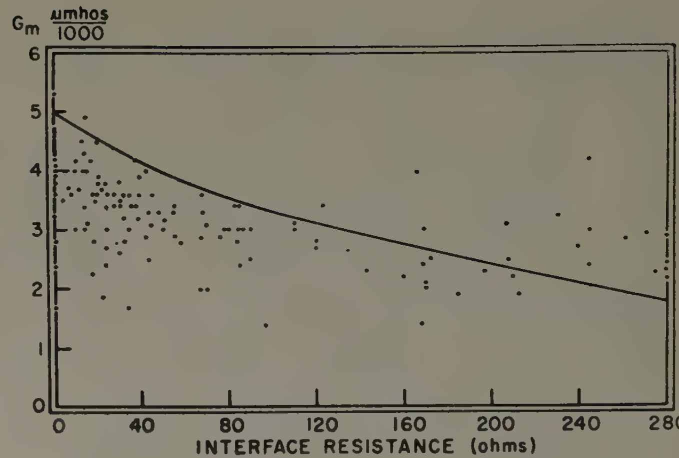


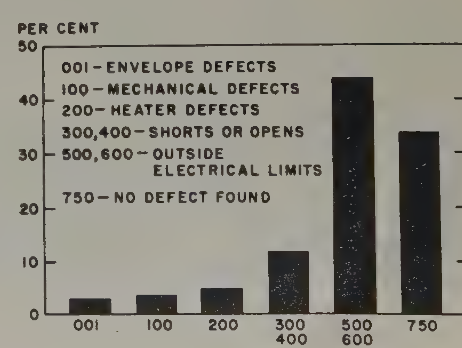
Fig. 9. 12AT7 removals from land-based Teletype equipment: Cathode interface resistance vs. G_m

also in an increase in the last bar on the chart, which represents the tubes in which no defect was found. The increase is from 25 per cent in Fig. 1 to 34 per cent on this chart.

A controlled test was initiated in ship-borne equipments, using 44 tube types in all applications available. The controlled tubes installed represented a cross section of the JAN tubes currently used. Fig. 11 shows the mortality rate of all tubes in this test. The upper curve represents the total removals at each time interval, expressed as a percentage of the total number of tubes in the test, and the lower curve represents the portion of the total returns which exhibited some defect on retest. The reason for the lower curve is that "no-defect" tubes from this base cannot be considered in the same group as the electrical failures, as was true of the returns from the other base discussed. Instead, these tubes which "test good" are scattered within the specification limits in about the same pattern as new tubes. As a further indication of their characteristics, a sample of 165 of the "no-defect" tubes was reinstalled in sockets identical or equivalent to those from which removed, and only two failed to operate satisfactorily. Some of the reinstalled tubes have now operated 3,000 hours without failing.

It is assumed that most of the removals of satisfactory tubes are the result of emergency maintenance practices under which more tubes may be changed than necessary to effect repair or the tubes are changed first and the real source of trouble traced to some other component after-

Fig. 10. Defect distribution of tubes removed from ship-borne equipments



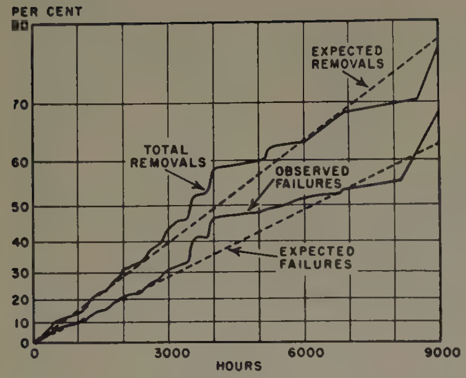


Fig. 11. Tube mortality with time, ship-borne equipments

ward. Tubes removed under such circumstances are seldom reinstalled. In any case, it appears that tubes in this category did not cause an interruption of service and should not be considered in calculations of equipment reliability.

On both curves in Fig. 11, the dotted line represents a calculated exponential that most nearly fits the measured data. It is noted that the measured result follows the calculated curve very closely for the first 3,000 hours. The hump in the measured curve between 3,000 and 4,000 hours is traceable to a maintenance period during which a group of *6AG7* tubes found to be below specification limits were removed.

It is possible that the maintenance period in question corresponds to the point at which, due to the normal G_m drift for the *6AG7* type, the large quantity of tubes at the center of the distribution would cross the lower G_m limit line. It is surprising that this would be detected, considering that so many tube types were included in the test and that different types would have different G_m decay rates. In this test, relatively large quantities of *6AG7* tubes were installed, and these tubes determined the failure rate at this point. Had the tubes been installed at staggered time intervals, this rise in failures would have distributed along the curve more evenly, and the measured data more nearly would fit the calculated curve. The test was made on a lot of new tubes, and a removed tube was not replaced with another controlled tube. Thus the quantity of tubes in the test decreased with time. Actual equipment operation demands tube replacement with failures, and at any period an equipment would have random operating times accumulated on each tube. Under this condition, the expected failure rate might be somewhat higher than indicated here.

The conduct of this controlled test was hampered by termination of controlled tubes due to shifting and modification of equipments after the first few thousand hours. Beyond 7,000 hours, too few tubes were left in the test to provide reliable data. Assuming that the calculated exponential failure rate shown is a good first approximation, it is possible to make predictions on equipment reliability due to tubes. The slope of the failure rates could be established over relatively short periods of time.

Similar curves may be drawn for aircraft environments; however, hours of operation accumulate much more slowly in these applications, and data in the thousands of hours for aircraft equipments are not now available. In general, the returns up to 500 hours indicate that the percentage tube reject rate is greater than in the environments discussed in this article.

New World's Record Set for Earth Removal

View of Marion 5561 stripping shovel which set new world's record for total cubic yards of earth moved in a 1-month period

A new world's record for total cubic yards of earth moved during a 1-month period has been set by an all-electric stripping shovel operating in the bituminous coal fields of southeastern Ohio. The record-breaking machine, a Marion *5561* shovel powered and controlled by General Electric apparatus, moved 1,622,883 cubic yards of overburden during October 1953 to surpass the previously established mark by more than 115,000 cubic yards.

The 1,500-ton shovel uses 4,700 equivalent installed horsepower in a coal strip-mining operation at the Georgetown Mine of the Hanna Coal Company. In approximately 15 seconds, the machine swings some 70 tons of overburden a distance of 240 feet to spoil-piles at levels as high as a 10-story building.

Heart of the electric system in the shovel is a 1,100-kw motor-generator set, driven by a 1,250-hp 1,200-rpm synchronous motor. This set uses two 375-kw hoist generators, a 220-kw swing generator, and a 135-kw crowd generator to provide variable-voltage direct current for the motors.

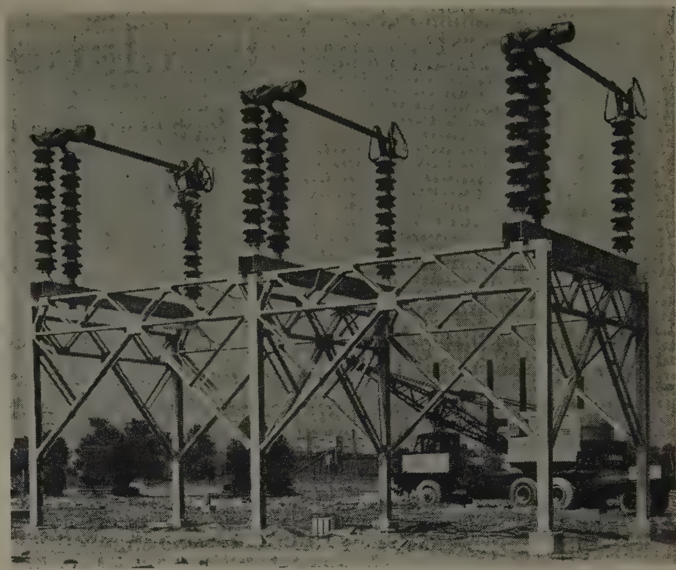
Shovel-type amplidyne control gives the operator quick and accurate response and assures reliable operation.

A 330-Kv Air Switch

I. W. GROSS
FELLOW AIEE

S. C. KILLIAN
MEMBER AIEE

J. M. SHEADEL
MEMBER AIEE



PREPARATORY WORK and preliminary design on an air switch to meet the 330-kv American Gas and Electric system requirements began several years ago while the general insulation problem of the system was being studied. After the 1,300-kv level, a stack of insulators seven high was selected for the switch; many preliminary tests were made on the stack. Various combinations of insulators were tested for strength and deflection and comprehensive corona and radio noise tests were conducted. Various switch types, vertical break, horizontal break, single break, double break, and multiple break, were studied and the vertical break chosen. However, if voltages are carried to any considerable distance beyond 330 kv, some sort of split-blade switch can be expected to reduce the extremely long blade length.

The blade length is 13 feet, 6 inches. Each single-pole switch is 18 feet long. With the blade closed the switch stands 13 feet high and with the blade open, 26 feet, 3 inches high. The live parts of a single-pole switch weigh 1,700 pounds. A complete single-pole switch weighs 5,400 pounds. The blade is a 5-inch outside diameter copper tube. The base is composed of two 12-inch I-beams. The continuous current capacity is 1,600 amperes. A 3-pole switch under construction in the field is shown in the title picture.

All test results following deal with a switch made up with stacks of seven standard 7-inch bolt circle insulators unless otherwise noted. Complete radio influence tests were made on the closed and open switch, using the Edison Electric Institute–National Electrical Manufacturers Association–Radio-Electronics-Television Manufacturers Association recommended method, both with and without control rings on the contact and mechanism ends. It was found that control rings were not required at the mechanism end because of the protection afforded by the large shields over the blade counterbalance springs and the generous radii on the various castings. Control rings were required at the contact end. The maximum radio influence voltage read at 200 kv line to ground (330 kv line to line, plus 5 per cent) was 200 microvolts.

Corona tests verified the need of control rings at the contact and the permissible omission at the mechanism. The minimum corona level on an open or closed switch was 215 kv, line to ground.

Sixty-cycle tests, wet and dry, on both open and closed positions gave the following lowest values; dry flashover, 799 kv; dry withstand, 750 kv; wet flashover, 640 kv; wet withstand, 609 kv.

Impulse tests, using a $1^1/_2$x40-microsecond wave on both open and closed switch, gave the following lowest critical values; positive flashover, 1,628 kv; positive withstand, 1,470 kv; negative flashover, 1,860 kv; negative withstand, 1,670 kv.

Since the switch was designed to be used with a stack of insulators that might be eight high, 1,425-kv basic impulse insulation level, the open gap of the switch had to be co-ordinated with this stack. It was agreed that the flashover of the open gap of the switch should exceed the maximum flashover on either the contact stack or the two mechanism stacks by at least 10 per cent. Therefore another insulator was placed in each stack and the flashover tests repeated. Then, in order to force flashover at the open-switch gap, two additional insulators were put into each stack and each end of the open switch surged with the other end grounded. From these tests the blade length, 13 feet, 6 inches, was determined.

Due to the operating characteristics of the American Gas and Electric 330-kv system, it may be necessary to de-energize the transformer at the end of a line while the line remains in service. In some cases no breakers will be used at the transformer end and the question arose as to the ability of an air switch to handle the exciting current on a 100,000-kva transformer, approximately 9 amperes. From experience in the lower voltages, it is known that a plain air switch, without any auxiliary interruptor devices, will not be able to perform this duty. A gas-blast interruptor device which has given exceptionally good results up to 161 kv, seemed to be the logical answer. This device mounts on a standard air switch and delivers gas into the arc stream by means of a porcelain tube mounted between insulator stacks. This tube is connected to a gas reservoir through a quick opening valve. This valve automatically opens, releasing gas which blasts the arc and extinguishes it. On test, at voltages to ground as high as 230 kv, the interruptor successfully broke 10.2 amperes of transformer-exciting current and 8.5 amperes of line-charging current.

Digest of paper 54-34, "A 330-Kv Air Switch," recommended by the AIEE Committee on Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1954.

I. W. Gross is with American Gas and Electric Service Company, New York, N. Y.; **S. C. Killian** is with Delta-Star Electric Division, H. K. Porter Company, Inc., Chicago, Ill.; and **J. M. Sheadel** is with Ohio Brass Company, Barberton, Ohio.

Electrical Insulation and International Standardization

E. F. SEAMAN
MEMBER AIEE

IN dealing with electric equipment, the engineer is concerned with three basic components that constitute the end product, namely: mechanical and structural parts, electric conductors, and electrical insulating materials. It is this latter element that challenges the ability of the electrical engineer and chemist, in the development of insulating materials that will improve in reliability with the concurrent development of materials intended for long life at elevated temperatures. Whether or not the performance for which the insulation is designed can be realized during industrial production must be determined by adequate test methods standards.

A view, in retrospect, of our standards for insulation and their thermal limitations starting with Dr. C. P. Steinmetz and B. G. Lamme, develops the conclusion that these pioneers in the electrical industry performed a remarkable task in laying the foundation for AIEE Standard No. *1*. Its worth has been proved over the years, but with the very great advances in the field of materials and the accumulation of a wealth of fundamental test data it is essential that our standards reflect this dynamic progress in industry. Such is the motivating influence on an international scale that has focused the attention of electrical engineers on the problem of developing more accurately evaluative standards for insulation and with special reference to temperature limitations.

In seeking an adequate solution to the problem thus presented it is required that the performance characteristics of the dielectric in terms of chemical stability, electrical quality, and mechanical durability be related accurately to the functions of time and temperatures, by the proper interpretation of data resulting from significant tests. Good test methods represent one of the key factors in developing a valid basis for time, temperature classification of electrical insulating materials. It is that phase of the work in which we now are engaged both on a national and international scope.

Technical Committee *15* Experts of the International Electrotechnical Commission (IEC) have reviewed the problem and recognized the need for answers that are sound technically and relatively permanent—as opposed to short-range expedient proposals. This thinking is summed up best in a statement by one of the Technical Committee *15* Experts delegates* which was supported by the committee and which reads:

"This Committee cannot support any plan, scheme or arrangement purporting to be quantitative unless it is subject to confirmation by an agreed method of measurement."

The current program in the U. S. is aimed at the integration of the views of the electrical engineering profession whether it be dielectrics as such, rotating machinery, transformers, or a host of other applications. The U. S. trends in this work are explored thoroughly in the articles of Dr. L. J. Berberich and K. N. Mathes. During the 1954 IEC meetings in Philadelphia, Pa., these articles undoubtedly will have considerable influence in directing the trend of the international standard as will the comments of other participating countries.

* Mr. Owen, United Kingdom delegate to IEC Technical Committee *15* Experts, 1953 Opatija, Yugoslavia, meeting.

International Activities on Thermal Evaluation of Insulating Materials

L. J. BERBERICH
FELLOW AIEE

THE introduction of many new insulating materials in recent years has led to the realization that the present national and international insulation temperature standards are not only inadequate, but difficult to interpret and often lead to ambiguities. This has resulted in relatively recent decisions to revise not only our own but also the international insulation temperature standards. In the United States, the present version of AIEE Standard No. *1*, covering the "General Principals Upon Which Temperature Limits Are Based in the Rating of Electric Machines and Equipment," dates back to the 1930's except for some revisions and additions in 1947. The definitions for the

various insulation classes (Classes *O*, *A*, *B*, and *C*) originally were written around two broad chemical groups of materials, namely, "organic" and "inorganic" materials. With the development of silicone and fluorocarbon materials another insulation class (Class *H*) was added in 1947. Its definition was written around what might be called these "organo-inorganic" materials.

The problem of developing more accurately evaluative standards for electrical insulation, especially with respect to temperature limitations, has become of international importance. These three articles deal with this situation. The activities of four groups working on the several phases of insulation evaluation in the U. S. and the International Electrotechnical Commission's actions are reviewed. The principles upon which test methods should be based also are discussed in some detail and the value of working towards temperature classification by functional test is stressed.

At the international level, there is the IEC Publication *34* which was revised last in 1935. Part I of this publication covers definitions for the various insulation classes with wording very similar to that used in AIEE Standard No. *1* except that the definition for Class *H* has not yet been added. It is the principal purpose of this report to review briefly the more important activities being carried on in this country and in IEC which are directed towards the development of background information on evaluation of insulating materials.

ACTIVITIES IN THE UNITED STATES

Since an AIEE standard is involved in this country, it is logical to expect most of the activities concerned with this standard to take place within the AIEE. There are now three groups within the AIEE working on the several phases of the problem of insulation evaluation. These and an American Society for Testing Materials (ASTM) group are as follows:

1. *The Working Group on Functional Evaluation of Rotating Machinery Insulation Systems.* P. L. Alger of the General Electric Company, Schenectady, N.Y., is chairman of this working group. This working group was appointed and is sponsored by the Subcommittee on Insulation of the Rotating Machinery Committee of which C. L. Sidway of Southern California Edison Company, who recently has succeeded the writer, is the present chairman. This working group was assigned the task of the development of functional testing methods for insulation systems as they are used in rotating machinery. The first test code developed by this group is now undergoing approval by the Standards Committee.

2. *The Working Group on Life of Insulating Materials of the AIEE Transformer Committee.* J. L. Cantwell of the General Electric Company, Pittsfield, Mass., is chairman of this working group. The working group was appointed and is sponsored by the AIEE Transformer Committee whose present chairman is J. A. Adams from the Philadelphia Electric Company. This working group was assigned the task of developing and establishing functional test methods which should lead to the preparation of a test code for evaluating the permissible operating temperature of insulating structures in dry-type transformers. Considerable progress in developing a model transformer already has been made by this group.

3. *The Working Group on Evaluation of Thermal Stability of Insulating Materials.* Dr. T. W. Dakin of the Westinghouse Research Laboratories, East Pittsburgh, Pa., is chairman of this group. This working group was appointed and sponsored by the Subcommittee on Dielectrics of the AIEE Basic Sciences Committee of which the writer is chairman. This working group was assigned the task of the development of test methods and codes for evaluating the thermal stability of insulating materials and to provide eventually the basic information necessary for the rational revision of AIEE Standard No. *1*. Rapid progress is being made in developing test codes for various classes of insulating materials.

4. *Section K on High-Temperature Performance of Electrical Insulation of Subcommittee XII of ASTM Committee D-9 on Insulating Materials.* K. N. Mathes of the General Electric Company, Schenectady, N.Y., is chairman of this section and Dr. G. M. L. Sommerman of the Battelle Memorial Institute, Columbus, Ohio, is chairman of Subcommittee XII on Electrical Tests. The functions of this group are (*a*) to determine the effect of elevated temperatures on insulating materials, and (*b*) to examine present test methods and to develop new ones where needed for the evaluation of thermal stability of insulating materials. This group is actively engaged in developing suitable test methods.

These four working groups, concerned with various phases of the problem of thermal evaluation of insulating materials and insulating systems, indicate the extensive nature of the activity in this field in this country. All of these groups are working now and some already have made considerable progress. It appears, however, that a number of years will be required before sufficient information becomes available for the extensive rational revision of AIEE Standard No. *1* and the present method for classifying insulating materials. In the meantime, AIEE Standards Coordinating Committee No. *4*, under the chairmanship of W. R. Hough of Reliance Electric and Engineering Company, Cleveland, Ohio, recently has completed a minor interim revision of AIEE Standard No. *1* which has been submitted to the Standards Committee for approval. The

A special introductory statement by E. F. Seaman is followed by the condensed texts of conference papers by L. J. Berberich and K. N. Mathes presented at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954, and recommended for publication by the AIEE Committees on Rotating Machinery and Basic Sciences.

E. F. Seaman, U. S. National Committee of the International Electrotechnical Commission, Chairman of IEC Technical Committee *15* Experts, is with the Bureau of Ships, U. S. Navy Department, Washington, D. C.; **L. J. Berberich**, who was a U. S. delegate on Technical Committee *15* on Insulating Materials of the IEC which met at Opatija, Yugoslavia, in June 1953, is with Westinghouse Electric Corporation, East Pittsburgh, Pa.; **K. N. Mathes** is with the General Electric Company, Schenectady, N. Y.

The statements contained in E. F. Seaman's article are based on the author's affiliation with the U. S. National Committee of the IEC and are not to construed as reflecting the views of the Department of the Navy.

present system of classifying insulating materials remains basically unchanged.

IEC ACTIVITIES

The first concrete evidence of interest in this field by the International Electrotechnical Commission appeared at a 1952 meeting of the Commission which was held in Scheveningen, Holland, where special Subcommittee *2C* of Technical Committee *2* on rotating machinery, together with Technical Committee *15* on insulating materials, were assigned the task of revising the present method of classifying insulating materials. At this meeting the following two proposals (which originated in Switzerland) were made: (*a*) to add two new insulation classes to the present number, and (*b*) to classify insulating materials by listing the various materials under the recognized insulation classes according to chemical composition, using such information on thermal endurance as may be available and experience as a guide. The two new classes proposed are Class *E* with a maximum hot-spot temperature limit of 120 C, which places it between Class *A* and Class *B*, and Class *F* with a hot-spot temperature limit of 155 C which places it between Class *B* and Class *H*. These proposals were embodied in IEC document *2C* (*Secretariat*) *6* dated December 1952. Lists under all of the various classifications are included in this document and, as might be expected, some rather serious errors were made in these listings because little or no test information was available to guide the preparation of these lists. The U.S. delegates present at this meeting stood almost alone in opposing these proposals. It appears to be impossible to eliminate errors in a system of classifying materials not based on quantitative test data. This already has become apparent in several revisions of the proposed lists of materials.

During the past year the U.S. National Committee of IEC gave further consideration to the proposals made at the 1952 meeting and decided to appoint a special subcommittee which was assigned the task of preparing a document, the purpose of which was to state clearly the U.S. position on these proposals. This committee consisted of K. N. Mathes (General Electric Company) chairman, E. F. Seaman (U.S. Navy Department), Dr. A. H. Scott (National Bureau of Standards), Robert Burns (Bell Telephone Laboratories), and the writer (Westinghouse Electric Corporation). W.R. Hough (Reliance Electric and Engineering Company) recently has been added to this subcommittee. The document prepared by this subcommittee was designated as IEC Document *15* (*USA*) *3*, *2C* (*USA*) *3*, dated April 1953. This document together with Document *2C* (*Secretariat*) *6* covering the proposed new system for classifying insulating materials were distributed widely among the IEC delegates, the various national committees, and to AIEE and ASTM members interested in these matters.

The 1953 meeting of IEC was held in Opatija, Yugoslavia, at the invitation of the Yugoslavian Government. While a total of 17 technical committees met, no meeting was scheduled for Technical Committee *2C* on rotating machinery insulation. A meeting was scheduled, however, for Technical Committee *15* (Experts Preparatory Committee). This committee met under the chairmanship of E.F. Seaman of the U.S. Navy, with the writer being the only other U.S. delegate on the committee.

The writer as U.S. delegate reaffirmed the U.S. national position as stated in Document *2C*(*USA*)*3*, *15*(*USA*)*3* referred to previously and emphasized the importance of making an immediate start on this long-range approach to the problem of insulation classification. The U.S. position may be restated briefly as follows: Instead of classifying materials by listing materials under the various classes according to chemical composition or defining them broadly as in IEC Publication No. *34* and AIEE Standard No. *1*, it should be possible ultimately to adopt definitive test methods for determining the thermal resistance of insulating materials in a quantitative manner. Since no generally accepted test methods exist at the present time it was proposed that: (*a*) the present classifications in IEC publication No. *34* with the addition of Class *H* as in AIEE Standard No. *1*, be continued as an interim international standard, and (*b*) the development of test methods which will serve to evaluate the thermal stability of insulating materials should be encouraged. It was made clear that this approach to the problem will require a long time, perhaps 5 or 10 years, and the need for making an immediate start on this problem was emphasized.

Support for our position was received first from the English delegates, then from the German and French delegates, and finally only the Swiss delegation was opposed. The Swiss delegation stated that, because of the absence of generally accepted test methods for evaluating the thermal stability of insulating materials, the U.S. proposal would require a considerable number of years to reach the status of an international standard. They then suggested, in view of this fact and the great need for an international standard, that further consideration be given to the method of classifying insulating materials which was proposed by them as an interim standard.

It was finally decided that further consideration should be given at the next meeting, which is to be held in September 1954 at Philadelphia, Pa., to both the interim proposal of the Swiss delegation and to the long-range proposal of the U.S. delegation. Since the Swiss stated that they had some new information which now makes possible the improvement of the lists of materials in Document *2C*(*Secretariat*)*6*, they were asked to prepare a new document incorporating their latest ideas. The U.S. delegation also was asked to prepare a new document which is to include information on plans for carrying out the long-range proposal. As far as the U.S. document is concerned, this is now being prepared by the special subcommittee appointed by the U.S. National Committee.

SUMMARY

It is apparent from the foregoing that there is a very great interest in the thermal evaluation of insulating materials both in this country and in Europe at the present time. The large number of papers on the 1954 AIEE Winter General Meeting program concerned with this subject is further evidence of this interest. The U.S. National Committee of IEC has proposed what is believed to be a scientifically sound system for classifying insulating materials which

will employ quantitative experimental data as a basis. It is hoped that the two IEC groups concerned, namely, Technical Committee *15* and Subcommittee *2C* of Technical Committee *2*, will give further favorable consideration to this proposal. It is now all too evident that the revision of insulation standards on both a national and an international basis has been neglected for too long. There is a great need for basic as well as practical information on thermal degradation of insulating materials upon which to base a scientifically sound revision of these standards. Fortunately, a very considerable effort now is being made in the U.S. to obtain this information. It is hoped that our European associates also will make important contributions in this field.

Principles for Temperature Classification of Insulating Materials by Functional Test

K. N. MATHES
MEMBER AIEE

METHODS for determining the temperature resistance of insulating materials used in electric equipment always have presented problems, which are the more difficult because they lie in the nebulous area between electrical and material engineering. Recently, the rapid chemical development of insulating materials and the increased need for their efficient use in electric equipment has led to new proposals for the temperature classification of insulating materials.

The present AIEE Standard No. *1* entitled "General Principles Upon Which Temperature Limits Are Based in the Rating of Electric Machines and Apparatus"[1] was first introduced about 1913.[2] Records from that time indicate the Standard was based largely on experience and that confirming experimental evidence was needed. Through many revisions, one dominating principle has been maintained in AIEE Standard No. *1*—the temperature classification of materials has been defined in terms of their composition, i.e., organic, inorganic, inorganic with organic bonding substances, etc. In 1913, relatively few insulating materials were available and hence could be classified quite easily by composition, but even then the records indicate that dissenting opinion claimed that composition alone was not a sufficient basis for temperature classification. In fact, the earliest standards of several countries recognized not only the material but the way in which it was used in arriving at limiting temperatures.

As early as January 26, 1898, temperature ratings were discussed by the AIEE.[3] International discussion of the subject occurred at least as early as the Milan Congress of 1906. In 1917 the British Standards Agency adopted temperature classifications for insulating materials[4] closely paralleling the earlier United States Standard, but this approach did not receive international recognition until about 1927.[5] Perhaps it is not surprising that the discussions and differences of opinion which existed for more than a quarter of a century provided a firm basis for a relatively long period of nearly absolute acceptance of the principles outlined in AIEE Standard No. *1*; but such stability is not a characteristic of engineering progress.

Through the years many new insulating materials have become available and in recent years the rate of their appearance has accelerated. The development of silicone resins with remarkable temperature resistance produced the first major change in AIEE Standard No. *1*. A new temperature classification, *H*, was defined with a limiting temperature value again dictated by majority experience with many dissenting opinions. Underlying this dissension existed experience with different silicones which actually had very different degrees of heat resistance. The concern originally voiced in 1913 that broad definitions of "composition" might not be sufficient to define temperature classifications was heard again and strongly.[6] However, a Standard which has been in existence for 40 years has force developed by this long usage alone. A different and better approach has to emerge and successfully face the established method. Such emergence must and should take considerable time and may follow several lines of attack at the same time.

The United States National Commission of the International Electrotechnical Commission (IEC) has proposed[7] that the present methods of classification be kept temporarily until better methods of temperature classification can be developed through two approaches:

1. Functional test methods for specific insulating materials which actually will evaluate the effect of elevated temperatures on the physical and electrical properties and the changes which occur during heat aging in terms which are significant in the operation of electric equipment.
2. Functional test codes for composite insulating systems used in different types of equipment, i.e., rotating, transformers, etc., which will evaluate the effect of elevated temperatures and the changes which occur during aging in terms which are significant in the operation of the equipment.

Such tests and codes will provide a basis first for comparing new materials to the older materials for which

considerable service experience exists and ultimately, it is believed, for temperature classification of materials by test. It is intended herein to suggest the principles on which such test methods should be based and to review the development that has taken place.

EFFECTS OF OPERATING TEMPERATURE

ELECTRIC EQUIPMENT may operate in high ambient temperatures or receive heat by radiation. Conductance, magnetic, and occasionally frictional losses add to the temperature to which the insulation system is exposed. The temperature is seldom constant but changes with load and other conditions. A temperature gradient exists between the hotter and cooler portions which changes under different conditions.

Insulating materials are affected in different ways by elevated temperatures as follows:

1. Softening and flow may occur—for some materials like nylon and Teflon at a critical temperature and for other materials like cellulose acetate over a temperature range.
2. A decrease in mechanical properties may occur even though true softening and flow are not encountered. Such behavior is typical of many epoxy and polyester resins.
3. Changes in electrical properties occur.
4. Over extended periods of time at elevated temperatures, changes in chemical or physical composition may occur which affect both mechanical and electrical properties in different ways, depending upon the material as follows:

(*a*). Some materials, like polyethylene, progressively soften and electrical properties may depreciate. In the case of polyethylene, such changes are accelerated by ventilation and the resultant oxidation, but for other materials, like some oil-modified resins, softening is accelerated by sealing and lack of ventilation (as under a lead cable sheath), which permits plasticization by low molecular weight decomposition products.

(*b*). Some materials, like phenolic resins, increase in hardness and ultimately may become brittle. In such cases, elongation usually is decreased but tensile, compressive, and shear strength may increase, decrease, or first increase and then decrease. With some materials, like certain silicones, flexibility at room temperature may decrease first, then increase, and finally decrease again accompanied by changes in thermoplastic characteristics at each stage. Other materials, like polyethylene terephthalate (Mylar), may develop changes in crystallinity and molecular orientation and such changes may be accelerated by contact with other materials like certain types of phenolic varnish.

(*c*). Some materials such as certain plasticized materials or alkyd resins may lose weight. This loss in weight may be due to loss of volatile constituents (plasticizers, etc.) or may be due to the production of volatile decomposition products through molecular rearrangement or oxidation. (Oxidation may result in an increase in weight if volatile decomposition products are not formed.)

Several of the various effects of operating temperature outlined simultaneously may affect the performance of an insulation system. Moreover, separate factors when combined with the effect of temperature may cause the actual failure. In such cases, degradation due to heat "weakens" the insulation system, which subsequently fails due to another factor—dielectric breakdown for example. The action of mechanical forces on softened or aged insulation is one of the most usual causes for insulation failure. Moisture is another factor which when combined with the effects of heat or aging commonly may cause insulation failure. In addition to causing breakdown directly, moisture absorbed by certain types of insulation can cause very high electrical losses when the insulation is subsequently exposed to normal operating temperatures. These high losses may induce thermal "runaway" unless the "drying out" which occurs simultaneously can proceed sufficiently rapidly to reduce the electric losses in time.

When the permutations and combinations of possible factors such as those outlined are considered, it readily can be understood why temperature classification of insulating materials by test has been considered to be so very difficult and arbitrary methods have been adopted instead.

PRINCIPLES UNDERLYING FUNCTIONAL TEST

THE VERY difficulties emphasized in the foregoing provide the basis of the need for functional test and perhaps also provide a clue to the solution of the problem. An epoxy resin might serve admirably as an impregnant for stationary control coils operating at 150 C because of its resistance to embrittlement during heat aging, but might have insufficient strength at temperatures above 100 C to serve as an impregnant for high-speed rotors. It is unfair by arbitrary temperature classification to condemn the use of such a material for the control coil or to allow it for the high-speed armature. It is obvious that the use for which a specific insulating material or an insulation system is intended must affect the temperature classification and its evaluation. This is, of course, the very meaning of functional test. Some principles pertinent to the development of tests for temperature classifications of insulating materials are outlined in the following:

1. It should be possible to interpret the results of tests so as to predict service performance.
2. A majority or at least a principal number of the factors involved in application should be included in the tests.
3. Test methods should be developed with specific service problems in mind.
4. Tests often should evaluate insulating materials in simple combinations characteristic of the ways in which they actually are used.
5. Test samples should be simple, easily made, and reproducible.
6. One basic form of sample should be adaptable to as many types of test as possible.

Much skepticism of temperature classification by test

arises because many tests have been used or interpreted improperly. For example, the mandrel flexibility test[8] for insulating varnish has been used to compare the heat resistance of different varnishes. From the point of view developed here, this test violates the foregoing principles 1, 2, 3, 4, and 6 since most varnish-treated structures are not bent severely during use and those which might be, like a cable braid, should be evaluated as a combination of fabric and varnish.

Implicit in this list of principles underlying functional tests is the use of an adequate and proper "end point." This problem is so universal and so important that it deserves special mention. It is obvious, for example, that decrease in insulation resistance may provide a clue to the condition of a heat-aged sample following a moisture cycle, but does not constitute an "end point" unless insulation resistance is of functional significance in the operation of the device in question. For high-impedance electronic circuits, a low value of insulation resistance may be a proper end point, while for motor insulation it probably is not, and dielectric breakdown should be used instead.

"Percentage" end points should be used with caution when evaluating insulation systems or materials for specific applications (it has been common to use some arbitrary percentage, say 50 per cent of an initial property such as tensile or dielectric strength as the end point of heat aging tests). The result of such an approach may be to unfairly penalize materials with a high initial value when compared to a material with a much lower initial value. Instead, a definite "end point" value usually should be adopted which has significance in terms of the operation of the device in question. However, if the "rate of change" of a particular property provides the significant information, then a percentage of the initial value can be used as the criterion.

A special problem of extrapolating short-time test results at high temperatures to results and times significant in terms of operation at normal temperature always has plagued the development of tests for temperature classification of insulating materials. A long series of investigations have studied this problem. Montsinger[9] and Scott[10, 11] developed the so-called "degree" rules for liquid and solid dielectrics. Nordlander* and Dakin[12] have interpreted such results in terms of chemical reaction rate theory, Malmlow,[13] working in part with data obtained by F. M. Clark, has added to this work. The importance of the homogeneity of conditions at various temperatures has been emphasized by many of these investigators. Despite the fact that good extrapolations have been established over wide temperature ranges for some insulation systems, it has become apparent for a number of materials that the factors influencing degradation at high temperatures may differ from those influencing degradation at lower temperatures. For example, silicones tend to oxidize at very high temperatures, while condensation and molecular rearrangement are more important at lower temperatures. Scheideler† has interpreted this more complicated problem in terms of chemical reaction rate theory using the concept of rate constants which are a function of the aging temperature.

Extrapolation of aging data is difficult also for insulation systems subject to autocatalytic degradation. Such degradation at a given temperature is characterized by an induction period in which a stabilizer or other ingredient is slowly used up and changes in properties may be small. However, at the end of the induction period, degradation may be very rapid. In such cases, it may be more important to determine the length of the induction period as a function of temperature than the rate of change of physical properties.

It is apparent that the foregoing should be kept in mind in interpreting and extrapolating data from temperature classification tests. Certainly results should be obtained at two temperatures at least and preferably three or more. Although test temperatures must be chosen which accelerate aging, too great an extrapolation should not be made until test information has been obtained which will substantiate the validity of the approach.

It is evident that considerable background has been developed for temperature classification by functional test. In the United States, the program is taking two directions: 1. Functional test codes for insulation systems. 2. Functional test methods for insulating materials.

FUNCTIONAL TEST CODES FOR INSULATION SYSTEMS

MANY STUDIES of the temperature aging of complete electric apparatus have been made.[11, 14–17] Harrington and Cypher[18] have described a model motor (now called a "motorette") used to study heat resistance characteristics with the saving of the considerable cost of full-sized equipment. Based to a considerable degree on the background developed in the "motorette" aging program, a test code for random-wound electric machinery[19] has been developed by an AIEE working group presided over by Alger. This test code includes provisions for evaluation of both motorettes and full-size small rotating machines stating as an objective the establishment of a sound basis for temperature classification for the immediate future in classes as now defined in AIEE Standard No. *1*, but ultimately for temperatures based on performance in such tests instead of solely on chemical composition. The test code has aroused interest and considerable experimental activity not only in the United States but other countries as well.[20] Herman[21] has carried out a program of aging of small motors following to a large extent the provisions of the test code. Proposals for a similar test code for transformers have been made by Narbut.[22] More test codes undoubtedly will be developed as experience is gained and additional needs are felt. It should be apparent, however, that it is probably impossible to develop such test codes for every type of electric equipment and the consequent importance of test on materials is emphasized thereby.

FUNCTIONAL TEST METHODS FOR INSULATION

MANY TESTS have been developed in an attempt to evaluate the effect of temperature on the stability of insulating materials. Much of this work is unpublished

* B. W. Nordlander, private communication dated 1943.

† A. L. Scheideler, private communication dated July 29, 1952.

but has been alluded to as illustrated in a recent article by Snadow.[20] Results of a program on the functional evaluation of insulating varnish in combination with magnet wire have been published[17, 21] and a limited correlation of functional test results on insulating materials with aging tests on complete motor insulation systems made.

Test methods for studying the heat stability of insulating materials for dry-type transformers have been described by Stewart[23] and results given which emphasize the importance of the surrounding atmosphere.

A considerable study of the aging stability of transformer oils and paper in oil systems has been described by Hill,[24] Clark,[25] and others.[26]

A number of other references pertinent to the problem of temperature classification are also available.[1]

CONCLUSION

DESPITE the complexity of the problem, temperature classification of insulating materials by functional test is feasible. Considerable progress already has been made and plans have been laid to accelerate this progress. Methods as developed perhaps can be used best to evaluate new materials in comparison with older materials for which considerable service experience has been amassed.

A number of principles which should underlie functional tests for temperature classification can be outlined. Perhaps the most important is as follows: the tests should justify the term "functional" and give truly significant results in terms of operation in specific types of apparatus. The factors, in addition to temperature, which affect the performance of the apparatus all should be factored, so far as possible, into the tests. The test samples should be simple, reproducible, and, in many cases, comprise simple combinations of insulating materials which can be adapted to carry out a variety of tests. Considerable attention should be paid to the use of significant "end points." The extrapolation of results obtained in relatively short times at accelerated aging temperatures to values for normal operating temperatures should be considered carefully and verified where possible.

The foregoing applies both to functional test codes for complete insulation systems and to functional tests on insulating materials or simple combinations thereof. Test codes on insulation systems should be developed for as many different kinds and types of apparatus as practicable. The areas in which such test codes may not be practicable should be recognized and test methods for materials developed keeping these applications particularly in mind.

It is not suggested that functional test methods be used to provide a basis for new or intermediate insulation temperature classes but that the temperature capability of each material be evaluated on its own merits for specific applications. The benefits to be accrued seem very important.

1. The most efficient use can be made of each material (particularly new and untried materials) in each type of application without the limitation imposed by arbitrary temperature classifications arrived at by what amounts at present to a pseudo-chemical definition of composition.

2. Equipment will not be limited by an over-all temperature classification (*A*, *B*, *H*, etc.) because each part (rotor, stator, etc.) can be designed to operate most efficiently at a temperature limited only by the characteristics of the insulating materials for the particular service involved.

3. Although broad temperature classes for insulating materials in the traditional sense should disappear ultimately, equipment standards will be feasible and perhaps in some ways even more strict than at present. Confidence should develop that temperature classification will be more significant in terms of service requirements. Such confidence is important both to the user of electric equipment and its manufacturer who must guarantee performance.

It is recognized that temperature classification by functional test is an ideal not yet attained but only approached. The goal is so worth while that every effort should be made and every co-operative approach tried to attain it as soon as possible.

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115-Kv Pipe-Type Compression Cable Installation

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THE CONSTRUCTION of a fuel-electric generating station at Toronto, Canada, by The Hydro-Electric Power Commission of Ontario, made it necessary to incorporate additional power into the existing 115-kv transmission system. Due to congested conditions in portions of this area, erection of steel tower transmission lines was not practical.

The decision to install high-voltage underground cable circuits was made with the knowledge that the route was composed of fill material having high acidity content and the consequent possibility that corrosion of the cable covering eventually would necessitate cathodic protection.

A well-tried cable type where dielectric voiding and ionization is controlled by means of pressure applied to a normal type of dielectric through the medium of an impervious membrane (lead) appeared to meet requirements.

The cable supplied for the 125-megavolt-ampere circuits is basically of the solid type manufactured of high-quality materials under strict control. A 1,000,000-circular-mil conductor of oval shape is screened with carbon papers, insulated with specially treated wood pulp paper, screened and lead covered with an 0.08-inch lead sheath to act as a flexible diaphragm.

High-quality mineral oil with additives to give viscosity comparable with that in solid cables and very low dielectric loss is used for impregnation.

Three such cores, after application of reinforcement for mechanical reasons and skid wires to aid installation, are "cabled" together and pulled into a steel pipe.

Dielectric thickness of 0.32 inch gives average stress values of 208 volts per mil with a maximum stress of 110 kv per cm on an insulation having assymptotic breakdown values in excess of 400 kv per cm on power frequencies and a resulting high safety factor.

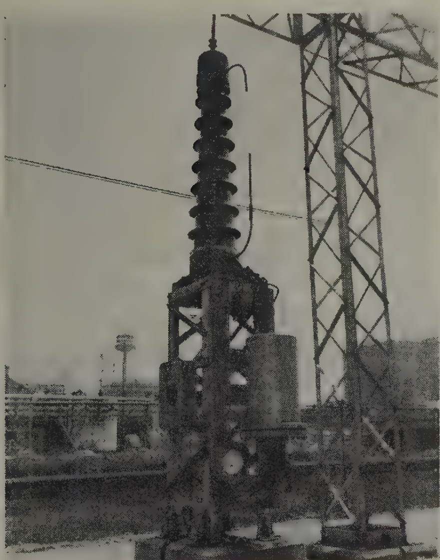

Fig. 1. Terminal structure with pothead

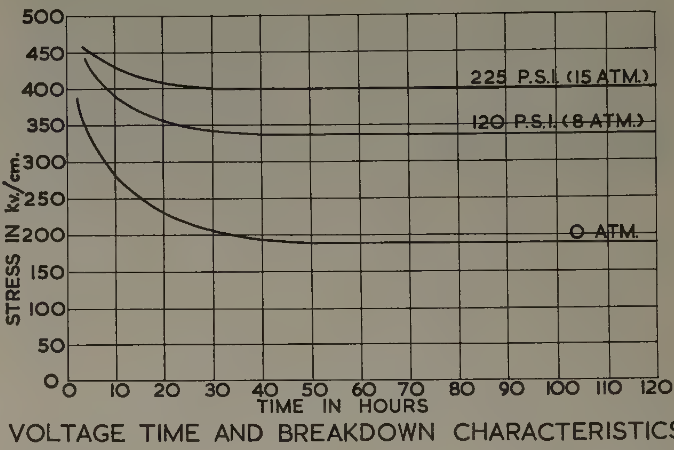

Fig. 2. Curves of stress in kv per cm versus time at 0, 120, and 225 psi

Conditions in a splice simulate the cable. A flush connector is screened with carbon paper, insulation is built back over the chamfered factory insulation with papers the same as those used in the cable construction and a flexible sleeve containing cable oil is fitted over all.

Pothead oil is maintained at 200 pounds per square inch (psi), as is the dielectric, by means of small membraneous tanks. Semiconducting glaze is used on the pothead porcelains.

To date no circuit has been operated up to rated capacity. Loads of 100 mva have given good indication that the installations will operate thermally within their design limits.

Gas pressures fluctuate over a 10 psi range; thermocouple readings indicate no hot spots on the lines.

Neither electrical breakdown nor mechanical difficulties have been experienced. Indications are that positive direct potentials exist at times on the steel pipe. This factor may result ultimately in corrosion of the pipe unless a biasing voltage is provided. Connection points, in strategic areas selected by ground potential and *p*H survey, already have been installed for this purpose and provision also made for detection of leaks with Freon gas.

Two installations were carried out in 1951 and 1952. In each case two pipe circuits were laid at 3-foot 6-inch spacing. Elimination of manholes simplified routing the pipes and left maximum access, in congested areas, for other utilities.

The coated pipes, supplied in 40-foot lengths, were supported on timbers over the open trench and lowered into position after welding testing and coating of pipe joints. Sand backfill replaced excavated material such as rocks.

Digest of paper 54-74, "115-Kv Pipe-Type Compression Cable Installations at Toronto, Canada," recommended by the AIEE Committee on Insulated Conductors and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1954.

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A 10,000-Mva 138-Kv Outdoor Oil Circuit Breaker

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THE RAPIDLY INCREASING demand for circuit breakers with extremely high interrupting capacities has resulted in the development of the 10,000-megavolt-ampere (mva) 138-kv 3-cycle oil circuit breaker which is described. The short-circuit current requirements of the new rating surpass those previously encountered at the higher transmission voltages including the 10,000-mva rating at both 161 and 230 kv. However, these and all other specifications have been met successfully with the breaker illustrated in Fig. 1.

The 3-tank construction has been welded to a structural steel base at the factory to form an assembly that is simple to install. The original alignment and mechanical synchronization of the poles and the operating mechanism are preserved when the breaker is skidded into position as a unit. In addition, the added rigidity of the base permits the use of a simplified foundation.

Two heavy-duty multiflow "De-ion" grids shown in Fig. 2 are employed as the interrupting elements in each pole. These are clamped to the bushings and are electrically interconnected by a conducting crossarm when the breaker is closed. With downward motion of the crossarm, contacts are opened, interrupting the circuit and establishing an isolating gap in clean oil beneath each grid.

The unusually high currents at which these grids must be effective have fostered several features of the design. A specially shaped arc horn functioning to stabilize the length of the pressure generating arc is provided in the chamber at the top of the grid. Also, the fibre structure which forms the central section is designed to withstand the pressures generated by the maximum fault currents and is equipped with exhaust channels of suitable configuration to discharge the large volume of ionized arc products from currents of this magnitude without any appreciable sacrifice in the performance at light currents.

Fig. 1. The new 138-kv breaker being loaded for shipment

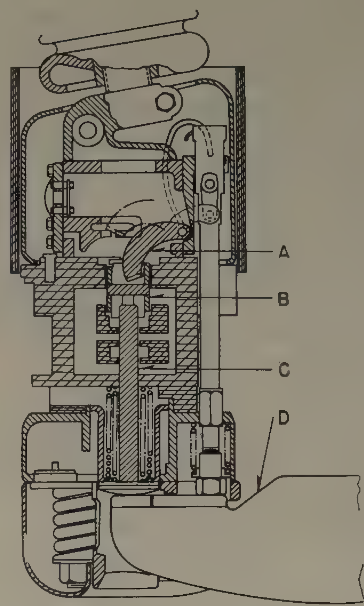

Fig. 2. Section view of the multiflow "De-ion" grid

A—Rotating-blade-type contact
B—Intermediate contact assembly
C—Bayonet-type lower contact
D—Actuating crossarm

The performance of the 138-kv 10,000-mva breaker has been carefully examined under laboratory conditions duplicating those anticipated in service. The mechanical equivalent of many years of life was simulated by test runs of several thousand operations during which the breaker was tripped under all significant conditions of load and contact position. The adequacy of the electrical insulation was determined by impulse withstand tests with crest voltages exceeding 650 kv and by 60-cycle withstand tests where the rms voltage exceeded 310 kv. Also, thermal behavior under load and overload conditions was evaluated with temperature runs lasting many hours.

In the high-power laboratory the interrupting characteristics were thoroughly investigated over the entire range from the light capacitive currents encountered when switching open-ended transmission circuits to the heavy currents associated with short circuits at full rating. Typical oscillograms show how precise control of such factors as asymmetry and timing may be exercised in the laboratory to obtain representative results. The high-power facilities also were utilized in checking the closing and conducting of the extreme currents encountered at the 10,000-mva rating.

These tests have demonstrated that the performance of the circuit breaker is excellent in all respects. Since conditions of service were duplicated and in many instances exceeded, it is believed that this breaker will fulfill very capably the extreme requirement of its 10,000-mva rating.

Digest of paper 54-32, "A 10,000-Mva 138-Kv Outdoor Oil Circuit Breaker," recommended by the AIEE Committee on Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1954.

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A Simplified Unit for Distance Relaying

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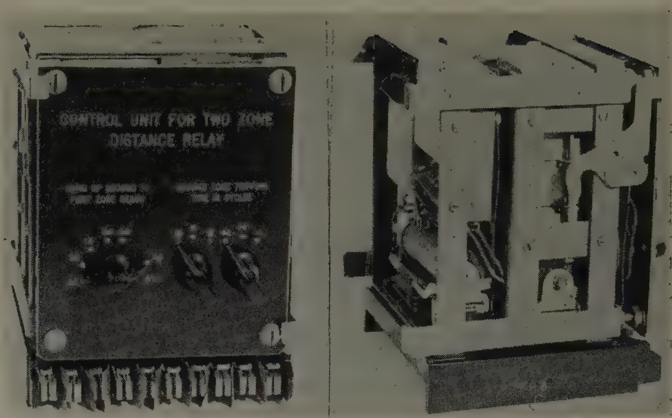


One method of providing an intermediate step between the performance, cost, and complexity of overcurrent and conventional 3-zone distance relays is described here.

RELAY APPLICATION naturally varies widely with the practices of the various operating utilities. However, it seems to be a general trend that for low-voltage short lines, simple overcurrent relays are employed most commonly, while for longer moderate- to high-voltage lines a high-speed form of protection is used such as high-speed distance relaying. Modern high-speed 3-zone distance relaying is necessarily more complex and expensive than overcurrent relaying, and, while the fine performance of these relays might be considered desirable for intermediate-voltage lines, cost factors may swing the balance to straight overcurrent relaying. One method of providing an intermediate step between the performance, cost, and complexity of these two basic forms of relaying is described here. A previous article[1] has described another scheme for providing distance relays economical for use on subtransmission lines.

There are available commercially 3-phase single-zone distance relays with a modified-impedance or mho characteristic, mounted with all three elements in one case and without a timer. These relays are less expensive than a complete set of 3-phase 3-zone relays but, by themselves, do not furnish complete protection for a transmission-line section. By building a suitable control unit employing a transfer relay and timing units, it is possible to use one of these single zone distance relays to give 2-zone protection to a transmission line. In building this unit it was recognized at the outset that there would be some sacrifice of speed. The use of a separate directional element will depend upon the offset characteristics of the distance elements selected and the system requirements. The characteristics of the distance elements have been published previously.[2–4]

DESCRIPTION OF THE CONTROL UNIT

THE CONTROL UNIT built to perform the transfer and timing functions is illustrated in the title picture and circuit diagram shown in Figure 1. The unit is contained in a case customarily used to house an induction overcurrent relay. The distance relay is normally adjusted for the desired first-zone reach (or slightly less as will be described later) and this reach is extended as desired for second-zone protection by the action of the tapped auxiliary autotransformer which is mounted within the control unit. The action of the control unit is described best in terms of two cases: a first-zone fault and a second-zone fault.

Since the normal position of the transfer relays is such that the relay is set for second zone, the distance relay contacts (*21*) close immediately on the occurrence of a first-zone fault, charging the capacitor C_1 and picking up auxiliary relay X which is a standard multicontact telephone relay. Relay X is held by capacitor C_1 for a predetermined length of time. When relay X picks up, the distance relay is immediately switched to a first-zone setting and, since this is the case of a first-zone fault, the distance relay remains closed. In the meantime capacitor C_2 has been charging and, after a short time delay caused by the charging operation, relay Y picks up and closes the tripping circuit.

In the case of a second-zone fault, the distance relay contacts close as before and relay X picks up, which transfers the distance relay to the first zone and causes the distance relay contacts to open again. When relay Y closes, the trip circuit is open. After a time delay controlled by C_1 and the associated resistance, relay X drops out and, if the fault was not cleared during the time delay, the distance relay contacts again close and complete the tripping circuit through the contacts of relay Y which has been held in by C_2.

After the fault has cleared, both capacitors discharge and the unit is reset for the next operation.

SETTING THE RELAYS

THE DETAILS OF application of the unit depend upon the type of distance relays to be used. The manufacturers' data on the usual distance relay give the relay reach in terms of tap settings based on a closing cycle. In the present application the relay already is closed and must open in the case of a second-zone fault. In the case of the balanced-beam type of construction it was found that the balance point was extended by as much as 35

Full text of paper 53-312, "A Simplified Unit for Distance Relaying," recommended by the AIEE Committee on Relays and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Pacific General Meeting, Vancouver, British Columbia, Canada, September 1–4, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

A. W. Adams is with the Bonneville Power Administration, Portland, Oreg., and **F. R. Bergseth** is with the University of Washington, Seattle, Wash.

The assistance of R. L. Schoenman, research fellow, in constructing the pilot model of this unit is acknowledged gratefully.

per cent on an opening cycle. The induction-cup-type relays also tested with this unit did not show this same characteristic of extended reach on an opening cycle.

Just as on a closing cycle, some delay must be anticipated in relay opening time for faults near the balance point. Relay Y must be delayed in closing until the distance relay contacts can open if second-zone operation is to be obtained. If relay Y closes too fast, the first-zone reach of the relay is effectively extended. This extension is illustrated in Fig. 2 where the reach of the relay as a function of resistance R_3 is plotted. Since too high a value of R_3 results in unnecessary time delay of tripping for first zone faults a compromise setting of R_3 was used in the laboratory tests which allowed approximately a 15-per-cent extension of the first-zone reach.

The autotransformer used for obtaining the second-zone reach has taps which permit the selection of the ratios between the reach of the first and second zones. An adjustable time delay for the second zone is obtained by a transfer switch which varies the capacitance in the delay circuit.

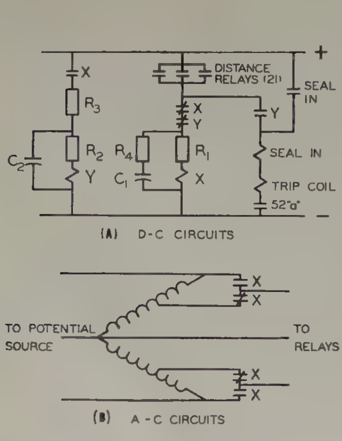
TESTS

The apparatus described was assembled and tested on an artificial transmission line in the laboratory. Various types of faults were applied, both first and second zone, and oscillograms were taken to check the operation of the control unit. Typical oscillograms for first- and second-zone faults are shown in Fig. 3. Second-zone time delay was adjustable up to 1/2 second.

As noted previously, the use of this unit adds to the total time of relaying, even for a first-zone fault. The time from the closing of the distance relay contacts to the closing of the trip circuit by relay Y must be charged against the unit. This lost time was approximately $1^1/_2$ cycles for the unit tested and this is felt to be well within the limits expected when this unit first was conceived.

SUMMARY AND CONCLUSIONS

The control unit as built and laboratory tested performed according to expectations. A means is provided thereby for a class of protection somewhere in the middle ground between the cost, performance, and complexity of overcurrent and conventional 3-zone distance relays.



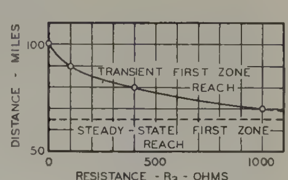


Fig. 1 (left). Circuit diagram of control unit

Fig. 2 (above). Influence of time delay of auxiliary relay Y on first-zone distance relay reach

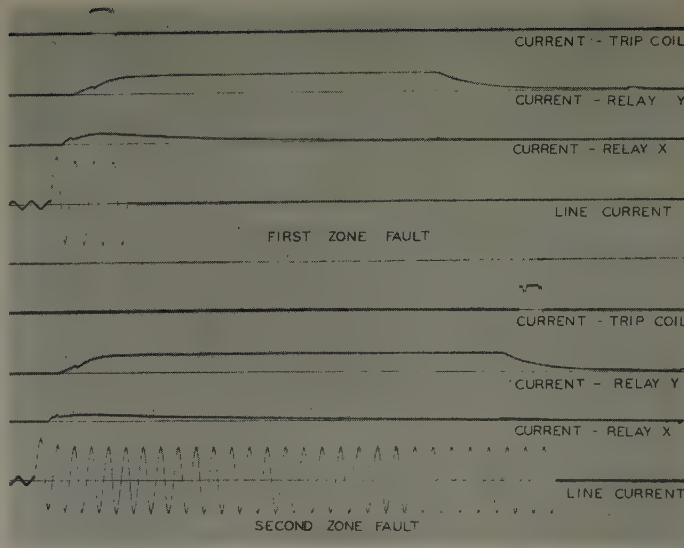


Fig. 3. Typical oscillograms taken from tests on an artificial transmission line

A relay time of approximately 2 cycles is obtained for first-zone operation and an adjustable time delay for second-zone operation. The ratio between first- and second-zone reach is adjustable. The results obtained are believed satisfactory for use on intermediate-voltage lines where overcurrent relays are inadequate.

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Shipbuilding and Radiography

Gamma radiography has found another field of application in the inspection of welds in ships. Isotope Products Limited were engaged recently to radiograph welds on one of the largest lake freighters yet built. Inspection was carried out on the most highly stressed welds. Isotope iridium 192 was used for this work.

The freighter was 700 feet long with a 78-foot beam and capacity of 800,000 bushels of grain. The welds examined were all amidships and they were main deck stringer butts and sheer strake butts. The hull was fabricated from $1^1/_2$-inch steel plate. The seams of the vessel were radiographed in short sections. The camera for some shots was positioned in the hold; for others, outside above the deck plates. Some shots were taken from the main passageway against the side of the ship, while in some cases the radioactive source was suspended outside the hull, beaming inwards. The general-purpose isotope camera could be positioned by one man for all these exposures.

Microwaves Used to Observe Commutator and Slip Ring Surfaces During Operation

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A method of using short-wave radio (microwaves) and waveguide components for observing and recording the surface irregularities of commutators and slip rings during the operation of the associated machines is presented. If reasonable care is exercised, measurements of surface irregularities in the order of 1/2 mil or less may be obtained.

IT IS assumed usually that commutator and slip ring surfaces are cylindrical and concentric with the axis of rotation. However, unusual conditions of failure of brushes, brush holder mechanisms, and brush shunts are often attributed to vibration caused by high bars and flats on commutators and eccentricities of commutator and slip ring surfaces. Unfortunately, static tests with gauges often fail to indicate the extent of the fault that exists during the operation of the machines due to the absence of rotational forces and dynamic unbalance during the static test. Efforts to devise equipment for observing the irregularities of commutator and slip ring surfaces during operation generally have not been successful.

PRINCIPLE OF OPERATION

THE basic principle involved and the components used are shown in Fig. 1. The principal waveguide component, the magic tee,[1] shown in Fig. 1, consists of an *E*-plane arm, an *H*-plane arm, and two collinear arms as illustrated. The peculiarities of this tee are that when the arms are properly matched, microwave energy entering the junction from the *H*-plane arm will pass into the collinear arms but will not enter the *E*-plane arm, and energy entering the junction from the *E*-plane arm will not pass into the *H*-plane arm but will enter the collinear arms. The two collinear arms are effectively in parallel for energy entering the junction from either the *H*- or *E*-plane arms. Also, the electric field vectors in the collinear arms are in phase for energy entering the junction from the *H*-plane arm while they are 180° out-of-phase for energy entering the junction from the *E*-plane arm. Conversely, electric field vectors in the collinear arms arriving at the junction 180° out-of-phase will enter the *E*-plane arm and not the *H*-plane arm.

With this brief review of magic tee characteristics, the operation of the apparatus shown in Fig. 1 may be understood. Microwave energy from a klystron oscillator (24,000 mc) is fed into the *H*-plane arm of the magic tee. This energy divides approximately equally between the collinear arms, that entering the right-hand arm being directed against the face of the commutator or slip ring from which a part is reflected back into the same arm. The energy entering the left-hand collinear arm is reflected from the adjustable short circuit at the end of that arm. If the effective length of the closed collinear arm is adjusted correctly, the reflected waves arrive at the junction 180° out-of-phase and, therefore, will enter the *E*-plane arm in phase. The vector field at the crystal detector in the *E*-plane arm will have a maximum magnitude, resulting in a large detector output. If the effective length of either collinear arm is changed, the magnitude of the vector field at the detector will be reduced and a modulation of detector output will result. Curve *A* of Fig. 2 shows the effect on detector output of increasing the distance from the reflecting commutator surface to the open end of the collinear arm, the length of the other collinear arm being adjusted to give maximum detector output for the zero position of the reflecting surface. It will be observed that the detector output passes through alternate minima and maxima as the reflecting surface is moved away, the distance between points of adjacent minima being 1/2 wavelength. If the short-circuiting plug in the left-hand collinear arm is moved 1/4 wavelength, the reflected waves will arrive at the junction in phase and the vector field at the detector and the detector output will be a minimum for the zero position of

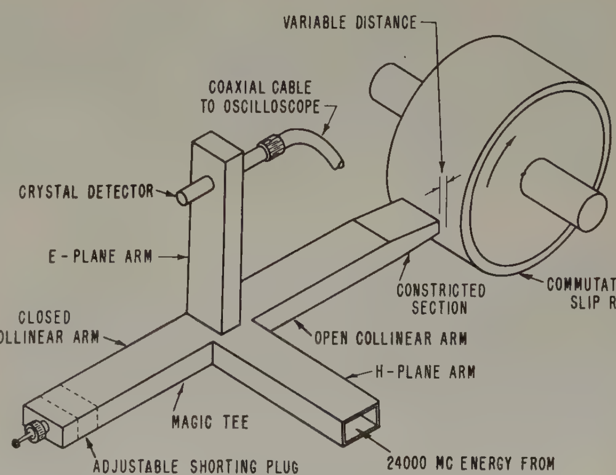

Fig. 1. Arrangement of waveguide components and associated apparatus for observing irregularities in revolving commutator or slip ring surfaces

Essentially full text of paper **54-90**, "The Use of Microwaves in Observing Commutator and Slip Ring Surfaces During Operation," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1954.

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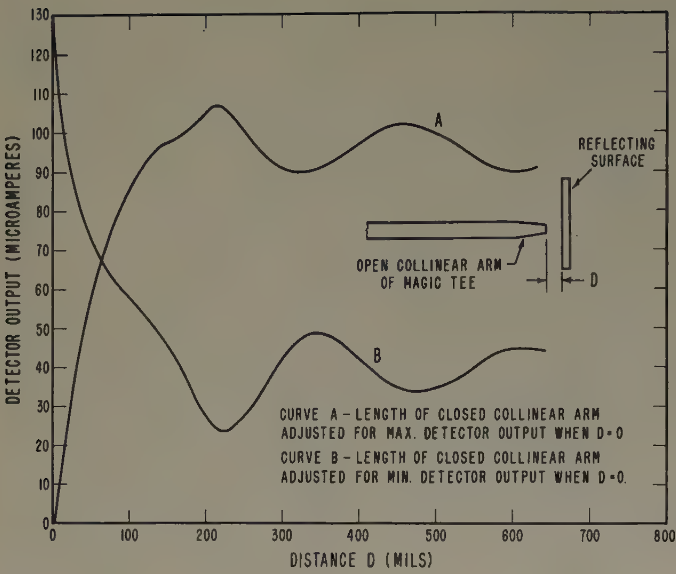


Fig. 2. Relation of detector output to the distance of reflecting surface from the end of the open collinear arm

the reflecting surface. Curve *B* of Fig. 2 shows the relation of the detector output and position of reflector surface for this condition.

It will be noted that the magic tee and its associated components constitute an a-c bridge, the balance of the bridge being obtained by the adjustment of the collinear arms and the oscillator frequency. Because the reflected portion of the energy incident on the reflecting commutator surface becomes less as the reflecting surface is moved away, it is not possible to obtain zero detector output except at zero position of the reflecting surface as shown by curve *B*.

EFFECT OF PARAMETERS

Changes in the distance of a revolving reflecting surface from the open end of the collinear arm due to irregularities in the surface are of primary interest. Therefore, a point of maximum slope on curves *A* or *B*, Fig. 2, is chosen for the operating position since this results in maximum modulation of detector output. In operation, the output of the crystal detector is connected to the input of the vertical amplifier of a cathode-ray oscilloscope, the horizontal sweep of which is synchronized with the rotation of the surface under observation.

From the preceding discussion it may be seen that the modulation of the signal voltage at the detector caused by irregularities in the commutator or slip ring surface will cause irregularities to be reproduced in the oscilloscope pattern. This is shown in Fig. 3*A* which is a graph of a slip ring surface on which the irregularities are produced by cemented aluminum foil strips of indicated width and thickness. Fig. 3*B* shows the corresponding oscilloscope pattern. The similarity of the graph and the oscilloscope pattern will be noted. Of particular interest is the approximately proportional relationship of the foil thickness and the vertical deflection of the scope pattern. However, as the width of the foil strip is reduced, the scope response will be smaller because the interval of signal generation is less. This effect is shown in Fig. 4*A* which is the oscilloscope response to 1.5-mil foil strips of increasing widths cemented to a 5-inch-diameter slip ring. Fig. 4*B* is a graph of the surface irregularities. Consideration of the theory involved leads to the conclusion that the oscilloscope response approaches zero as the width of the strip becomes infinitesimal.

When the apparatus is used to observe a commutator surface, as shown in Fig. 5, the reflecting surface is broken by the mica spacers between bars. The reflecting surface at the spacers is the bottom of the slots formed by the spacers. The change in distance from the open collinear arm to the reflecting surface caused by the slots will modulate the detector output and produce a ripple on the oscilloscope trace as shown in Fig. 6, which is an oscilloscope trace obtained by scanning the surface of a $2^5/_8$-inch-diameter commutator operating at 4,000 rpm. This commutator, made up of 55 bars, had 2-mil foil strips cemented to bars *1* and *5*

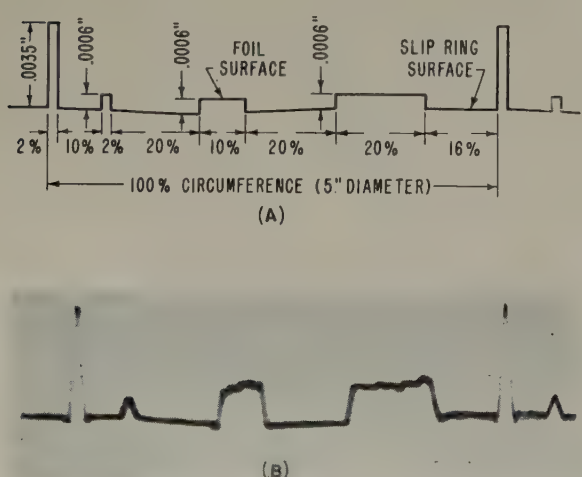


Fig. 3. Effect of surface irregularity height in a 5-inch-diameter slip ring on the oscilloscope pattern

A—Graph of slip ring surface
B—Oscilloscope record of surface irregularities

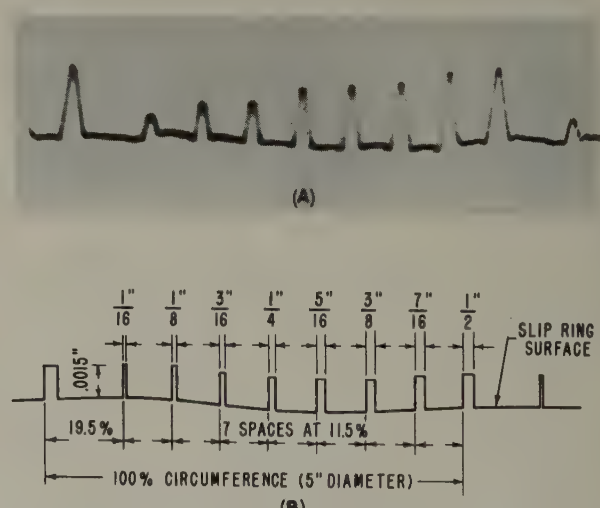


Fig. 4. Effect of surface irregularity width in a 5-inch-diameter slip ring on the oscilloscope pattern

A—Oscilloscope record of surface irregularities
B—Graph of slip ring surface

for the purpose of comparison and indexing.

The sharpness of the pulses produced by the slots depends upon the slot spacing or bar width and upon the dimension of the incident energy beam in the direction parallel to the motion of the surface. To show the effect of bar width, four groups of equally spaced slots were milled across the face of a 5-inch-diameter slip ring with the spacings shown in Fig. 7*A*. The resulting oscilloscope record is shown in Fig. 7*B*. It will be noted that the pulse pattern becomes less distinct as the bar width is reduced. In order to show clearly the bar pattern for narrow bars, it bcomes necessary to constrict the open-ended collinear arm as shown in Fig. 1 or reduce the beam width by means of the matching stub shown in Fig. 10.

However, if the energy beam is too narrow in relation to the bar width, and the arm lengths are improperly adjusted, the oscilloscope trace will show the surface represented by the bottom of the slots and will not show correctly the surface of the commutator. This is illustrated in Fig. 8*A* which is the oscilloscope record of a $3^1/_2$-inch-diameter dummy commutator of 35 bars created by milled slots whose depth increased by 1-mil increments. A 2-mil foil cemented to one of the bars does not register in this trace. When the width of the energy beam incident on the commutator surface is increased relative to the bar width by a 90° rotation of the open collinear arm waveguide and with proper adjustment of the components, the commutator surface is scanned correctly as shown in Fig. 8*B*. Note that the high bar created by the 2-mil foil now registers.

When the revolving surface is cylindrical but is not con-

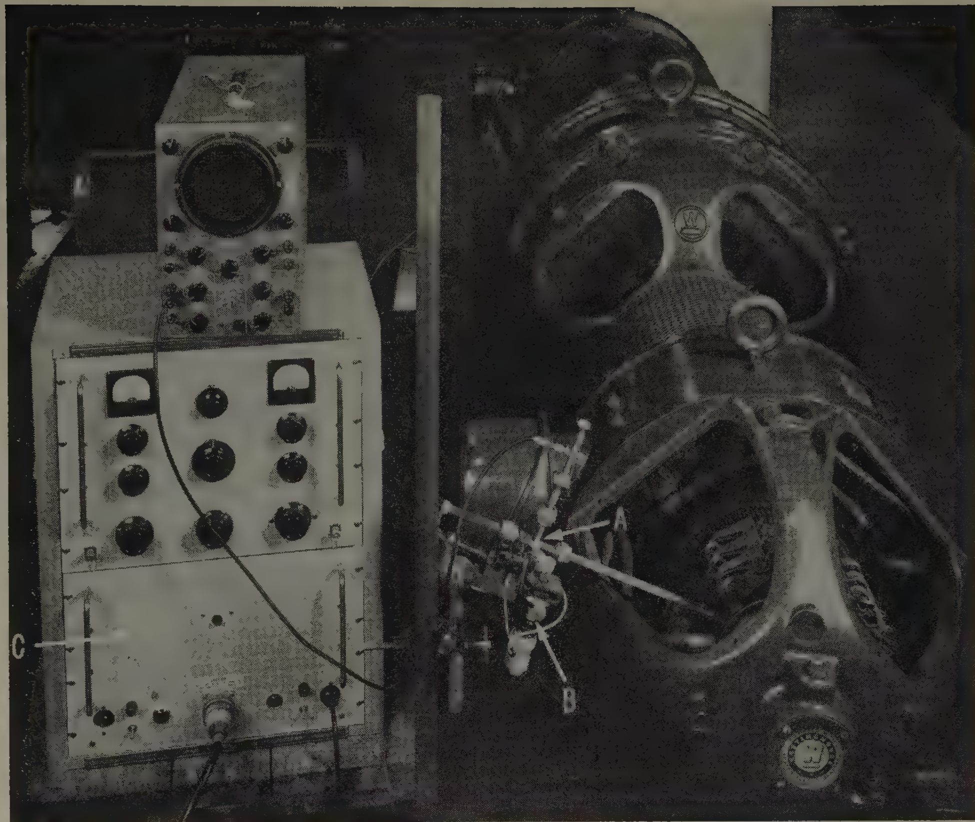


Fig. 5. Assembly of apparatus for observing a commutator surface while the machine is in operation

A—Magic tee *B—Klystron oscillator* *C—Oscillator power supply*

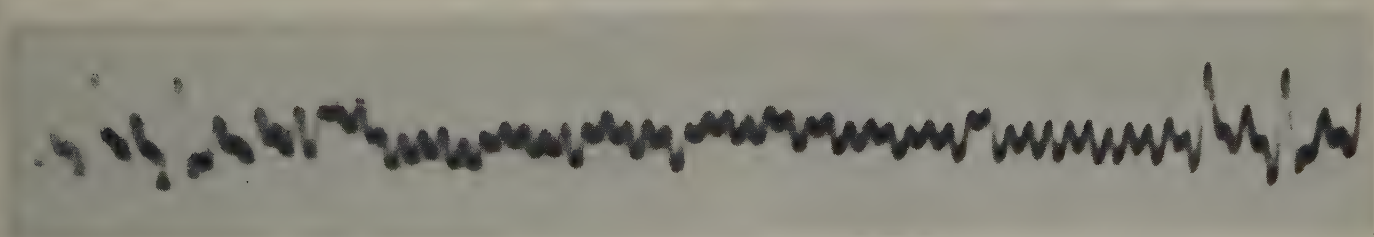
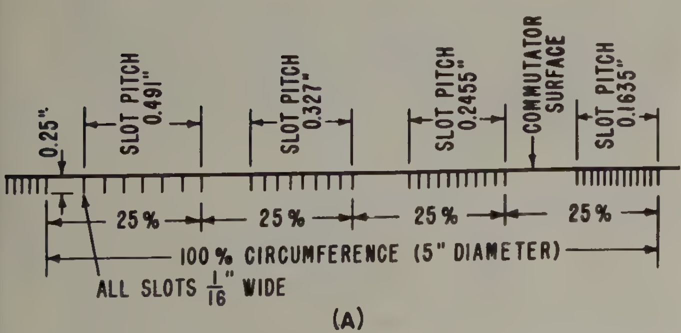


Fig. 6. Oscilloscope record of a $2^5/_8$-inch-diameter commutator of 55 bars operating at 4,000 rpm



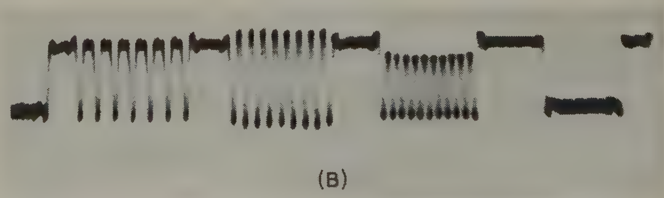


Fig. 7. The effect of bar width on oscilloscope pattern

A—Graph of commutator surface
B—Oscilloscope record of bar width

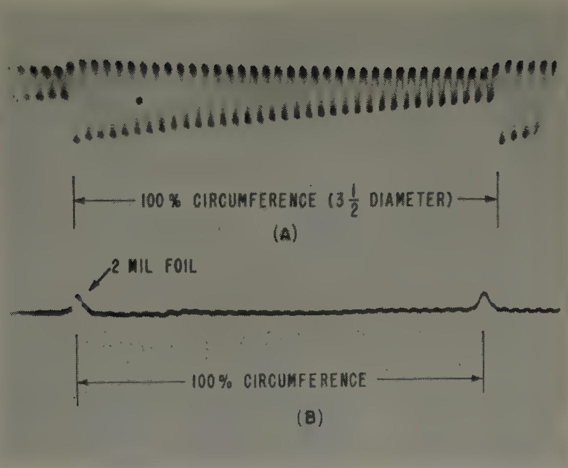


Fig. 8. The effect of beam width and focusing on oscilloscope pattern

A—Narrow beam focused on bottom of slot
B—Wider beam focused on commutator surface

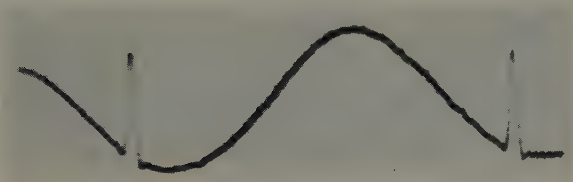


Fig. 9. Oscilloscope record of eccentricity in a 5-inch-diameter slip ring surface. The sharp pip is caused by a 2-mil foil strip cemented to the slip ring surface

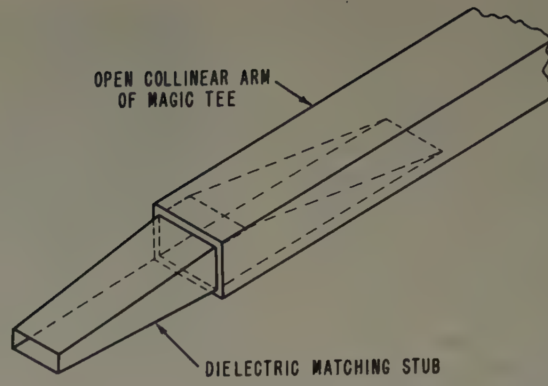


Fig. 10. Dielectric matching stub used for reducing beam width

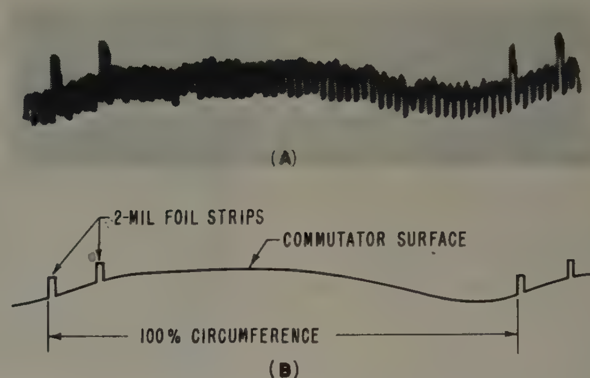


Fig. 11. Surface contour of a 56-bar 15-inch-diameter commutator on a 36-volt 1,390-ampere 4-pole 1,200-rpm generator

A—Oscilloscope record of commutator surface
B—Graph of commutator surface

centric with the axis of rotation, a variation of the distance from the reflecting surface to the end of the open collinear arm will occur. The variation of this distance and the resulting modulation of the detector output will be approximately sinusoidal. This is shown in Fig. 9 which is the oscilloscope pattern for a 5-inch-diameter slip ring with a 2-mil eccentricity. A 2-mil foil 5/16 inch wide was cemented across the slip ring near the low point in the surface for the purpose of calibration. A close examination of the base line in Figs. 3*B* and 4*A* shows eccentricity in the order of 0.2 mil in the 5-inch-diameter slip ring's surface.

PRACTICAL NOTES ON OPERATION

FROM the preceding discussion it may be seen that the oscilloscope pattern obtained by scanning a revolving commutator surface depends upon the relation of beam width to bar width and upon the proper adjustments of equipment. The results of experiments indicate that a

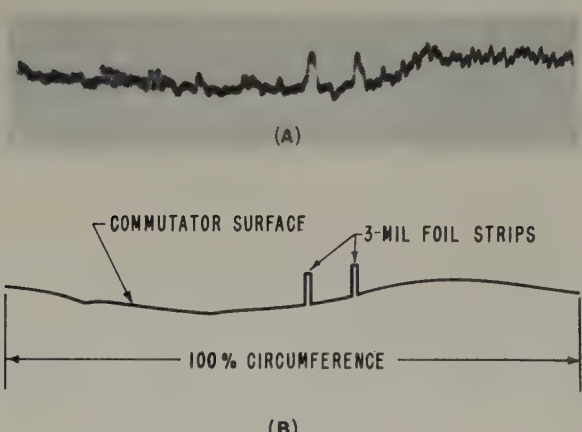


Fig. 12. Surface contour of an 85-bar 9.5-inch-diameter commutator on a 90-hp 250-volt 1,800-rpm motor

A—Oscilloscope record of commutator surface
B—Graph of commutator surface

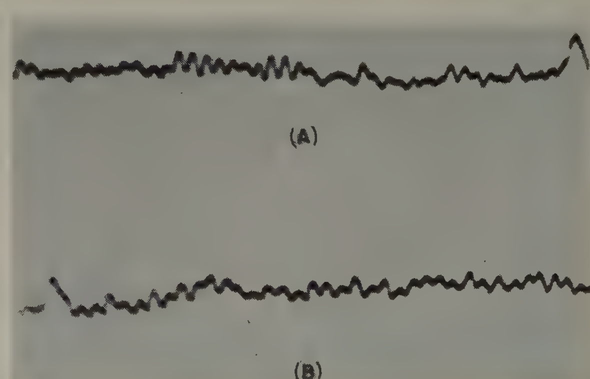


Fig. 13. Expanded oscilloscope trace of the record shown in Fig. 12A

A—Left-hand section of trace
B—Right-hand section of trace

beam width approximately equal to the bar width will give a satisfactory pattern when the adjustment of arm lengths is made properly. The beam width may be controlled by constricting the waveguide at the open end as shown in Fig. 1 or by the use of a tapered dielectric matching stub as shown in Fig. 10. The stub may be polystyrene or any similar material. The taper of the stub should conform with accepted waveguide practice. It also serves as a safety insulator to prevent accidental ground faults when used on energized machines.

Fig. 14. Oscilloscope record of a 10-inch-diameter slip ring surface on a 125-hp 1,800-rpm synchronous motor during operation: 1 revolution shown

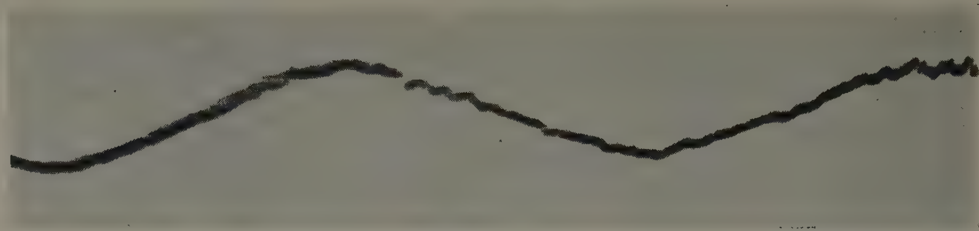


Fig. 15. Oscilloscope record of the vibration pattern of a carbon brush riding on a 5-inch-diameter slip ring whose surface eccentricity is 2 mils: Operating speed 3,600 rpm

The choice of frequency fixes the waveguide dimensions. However, the chosen frequency should be such that frequency stability is satisfactory. For the bar widths usually encountered, a frequency of 24,000 to 30,000 mc seem to give satisfactory results. Although the theory of operation is based on the magic tee, a directional coupler[1] with suitable waveguide components may be used to replace the magic tee.

A d-c or an a-c amplifier may be used in the oscilloscope. However, the amplifier should be entirely free of stray voltages and noise since it generally is used at a high gain. The horizontal sweep of the oscilloscope should be linear. Internal synchronizing is generally satisfactory, however, in the case of an almost perfect commutator or slip ring, it may be necessary to provide an external synchronizing signal to prevent the oscilloscope pattern from drifting. Especially is this true when the speed of rotation is not stable.

RESULTS OF TESTS ON OPERATING MACHINES

Tests have been made on several available machines using the apparatus described to determine the condition of the commutator and slip ring surfaces during operation. The oscilloscope records were compared with static tests made with a dial gauge on the commutator surface and results found to be in close agreement.

Fig. 11*A* shows the oscilloscope pattern obtained from a 56-bar commutator of 15-inch diameter, on a 36-volt 1,390-ampere 4-pole 1,200-rpm generator. Foil strips of 2-mil thickness were cemented on bars *1* and *7* for the purpose of comparison and calibration. Although this commutator surface apparently was in good condition, a static test with a dial gauge showed approximately a 2-mil variation in surface contour as indicated in Fig. 11*B*.

Fig. 12*A* is the oscilloscope pattern of an 85-bar commutator of 9.5-inch diameter on a 90-hp 250-volt 1,800-rpm motor. Foil strips of 3-mil thickness were cemented on bars *1* and *8*. Although the commutator surface appeared to be in good condition, a static test with a dial gauge indicated a maximum variation of 4 mils in the surface contour as shown in Fig. 12*B*, which is a graph of the commutator surface as observed with a dial gauge. It will be noted that the eccentricity shown by the oscilloscope traces in Figs. 11 and 12 agree closely with that measured with a dial gauge.

As the number of bars on a commutator becomes larger, it becomes increasingly difficult to register the individual bars in photographing a single trace on the oscilloscope. This difficulty may be overcome by expanding the sweep of the oscilloscope and photographing the trace in two or more sections, shifting the trace by means of the horizontal position control. Some identifying point on the trace is needed to tie the two sections of the trace together. This identifying marker may be a foil strip cemented to a bar. Fig. 13 shows in two sections the oscilloscope pattern of Fig. 12*A*.

For machines with multiple brushes per arm, one row of brushes may be lifted and the calibrating foil strip may be cemented to the bars in the track thus cleared. By this means, the commutator test may be made on the machine while it is in normal operation. In the case of slip rings or single brush per arm commutators, it is necessary to omit the foil strips if it is not possible to lift the brushes. Fig. 14 shows the oscilloscope record of the surface contour of a 10-inch-diameter slip ring on a 125-hp synchronous motor during operation.

Vibration[2] of brushes also may be observed and recorded without disturbing the brush by placing the end of the open collinear arm near the top surface of the brush. Fig. 15 shows the vibration pattern of a brush riding on a 5-inch-diameter slip ring which had an eccentricity of 2 mils. In this case and when no calibrating foil is used, calibration of the apparatus may be accomplished by comparing the record with that made from a vibrating tuning fork of known amplitude.

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Equipment Grounding for Industrial Plants

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After pointing out what an important factor no grounding or inadequate grounding has been in electrical work injuries, the components of an equipment grounding system are discussed. Then the grounding of power station and distribution equipment, stationary utilization equipment, and portable equipment are considered.

THE published data of the Division of Industrial Safety, Department of Industrial Relations, State of California, states that in the year 1951 there were 577 recorded electrical work injuries, of which 31 were fatal. For comparison the similar figures for several previous years are given, which indicate that 1951 was below the average both in number of total injuries and fatal accidents.

Year	Total	Fatal	Ratio
1946	305	28	10.9
1947	572	57	10.1
1948	755	48	15.7
1949	693	42	16.5
1950	690	33	20.9
1951	577	31	18.6

Of the 577 recorded injuries, 117 could be related directly to contact with frame case, or noncurrent-carrying metal parts. It was found that in these 117 recorded injuries, either no grounding or inadequate grounding could have been responsible for the injury. One of these accidents was fatal. This one involved a 440-volt motor wherein one of the energized conductors was in contact with the metal terminal box of the ungrounded motor frame.

Inasmuch as adequate equipment grounding tends to keep the potential difference between equipment frame and ground within safe limits, it can be said that these 117 accidents, or approximately 21 per cent of the total, were attributable to inadequate equipment grounding.

From the National Safety Council some statistics were obtained which, when combined with the preceding, provided the results shown in Table I.

The projected figures are based on the fact that one death out of 6,440 total from all causes was due to inadequate grounding. Because the rates per 100,000 population for the state of California and for the total United States were very nearly the same, it was assumed that the state was representative of the whole United States. Thus 94,000 divided by 6,440 indicates 14.6 deaths, and 117 times 14.6 indicates 1,710 injuries, resulting from inadequate grounding in industrial plants in the United States. It is believed that this is a very conservative figure.

In this world of statistics, where results seldom appear in less than 7-digit numbers, the preceding data may not sound impressive. In lost time it might prove to be significant. But loss of 15 or more lives in one year cannot be overlooked, particularly when it could have been avoided by adequate equipment grounding. The conclusion is obvious. Adequate equipment grounding is one of the most important factors in safety to personnel in industrial plants.

The increased use of system neutral grounding has focused attention on the necessity for good equipment grounding systems to obtain a low-resistance return path for ground fault currents. For safety to personnel it is generally recognized that equipment grounding is required but it often is

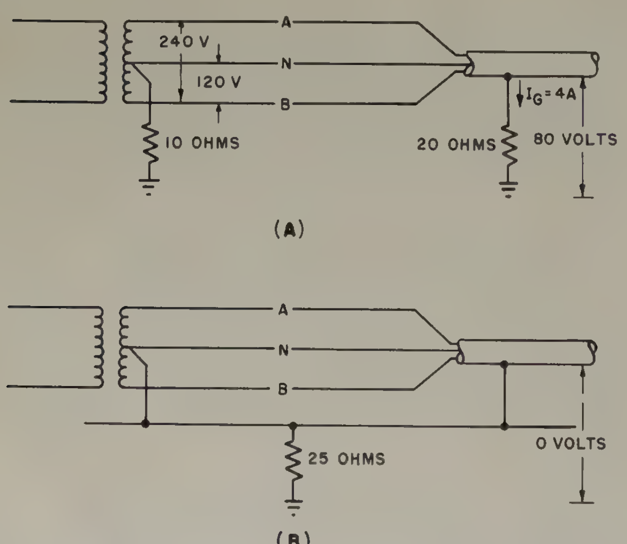

Fig. 1. The importance of a continuous metallic ground return path of low resistance

Table I. Injuries Resulting From Accidental Causes: 1951

Description	Injuries	Deaths	Rate Per 100,000 Population	Ratio of Injuries to Deaths
Statistics				
Total U.S.—all causes		94,000	61.3	
Total U.S.—all industry	2,100,000	16,000		131
California—all causes		6,440	60.8	
California—electrical work	577	31		18.6
California—inadequate grounding	117	1		117
Projected				
Total U.S.—inadequate grounding	1,710	14.6		117

Essentially full text of a conference paper presented at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953, and recommended for publication by the AIEE Committee on Industrial Power Systems.

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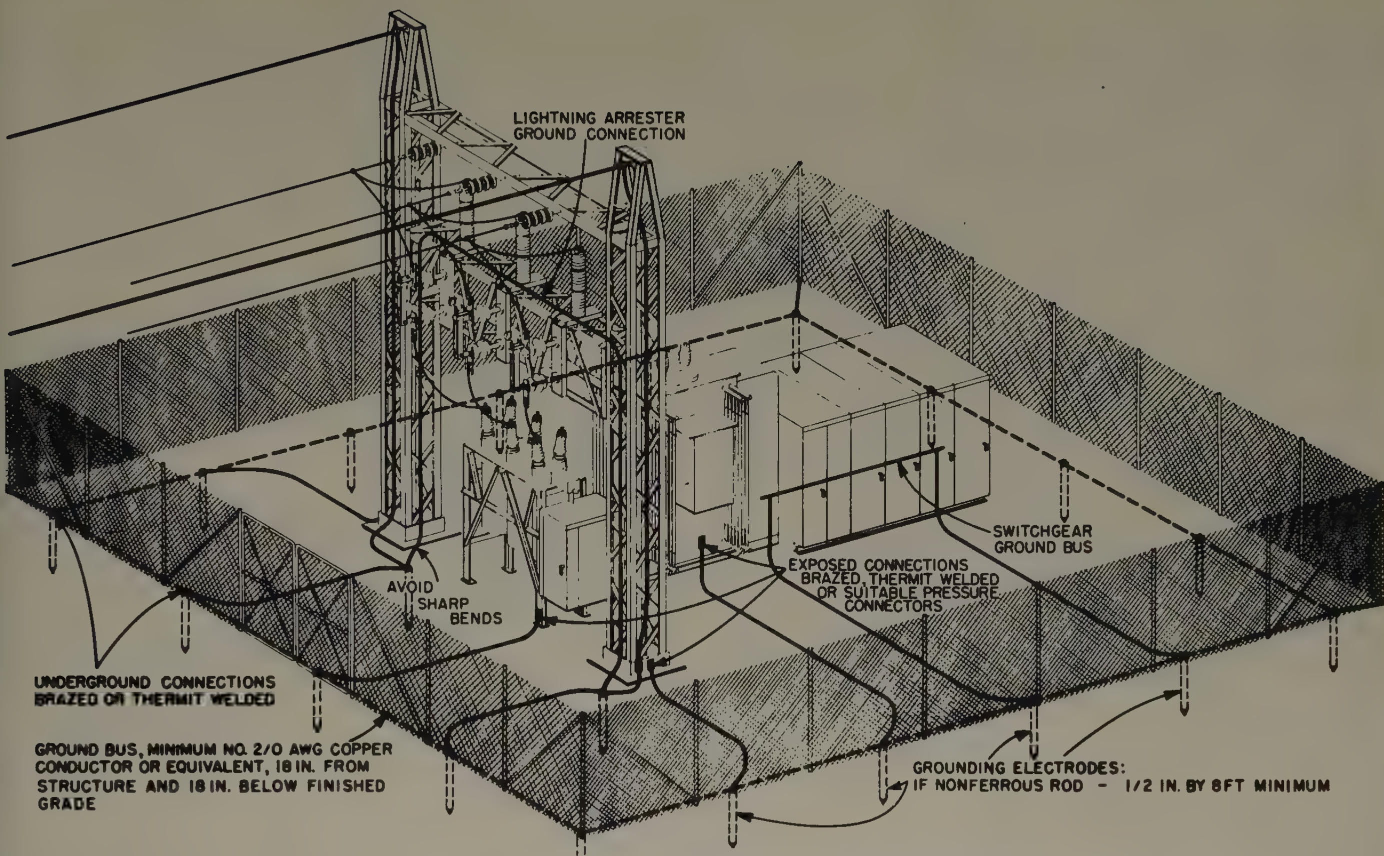

Fig. 2. Typical grounding system for an outdoor substation

provided as an afterthought and consequently may or may not be adequate for the purpose intended. With a little careful consideration it becomes apparent that a well-planned equipment grounding system must be provided whether the system neutral is grounded or not.

EQUIPMENT GROUNDING

Equipment grounding consists of the connecting to ground of noncurrent-carrying metal parts of the wiring system or apparatus connected to the system. The object of equipment grounding is to limit the potential between separated noncurrent-carrying parts, and between these parts and earth to a safe value under all conditions of normal or abnormal system operations. To accomplish this objective, a plant grounding system is provided to insure that all parts of the building structure and apparatus shall be at the same potential. By providing such a level of uniform potential under and surrounding the structure, the chances of large differences of potential within reasonable reaching distance of a person are reduced.

COMPONENTS OF AN EQUIPMENT GROUNDING SYSTEM

An equipment grounding system consists of connections to earth, a grid or network used to establish a uniform potential in and about the structure, and connections to equipment frames and enclosures. Connections to earth generally are referred to as grounding electrodes or ground rods. The grid or network usually is designated as the station ground bus. Connections to equipment frames and enclosures are called grounding conductors.

A continuous underground water piping system provides a very satisfactory grounding electrode. Artificial grounding electrodes should be used also. Such electrodes may be rods, pipes, plates, or conductors imbedded in the earth. They should be of noncorrosive metal, such as copper or copper-bearing steel.

The ground bus should be connected solidly to the grounding electrodes. The ground bus must provide a number of low-resistance paths to earth, and more important, it should provide multiple low-resistance return paths for ground fault currents. The importance of a continuous metallic circuit of low resistance in the ground path is illustrated in Fig. 1. Fig. 1*A* shows a 120/240-volt single-phase system with transformer neutral connected to ground through a grounding electrode which measures 10 ohms resistance to earth. The conduit is connected to earth through a separate grounding electrode which measures 20 ohms to earth. A fault occurs between conductor *B* and the conduit. The ground fault current will be equal to 120/30 or 4 amperes. This will not be of sufficient magnitude to operate interrupting devices but the voltage drop from conduit to earth will be 4×20 or 80 volts.

Fig. 1*B* shows the same system with both transformer neutral and conduit connected to the common ground bus which is connected to ground through a single grounding electrode which measures 25 ohms resistance. A fault occurs between conductor *B* and the conduit. A high fault current will flow through the low-resistance return path causing fault interrupting devices to operate. Little, if any, current flows through the 25-ohm resistance and therefore the conduit will remain very close to earth potential. It is not intended to imply that 80 volts potential is necessarily

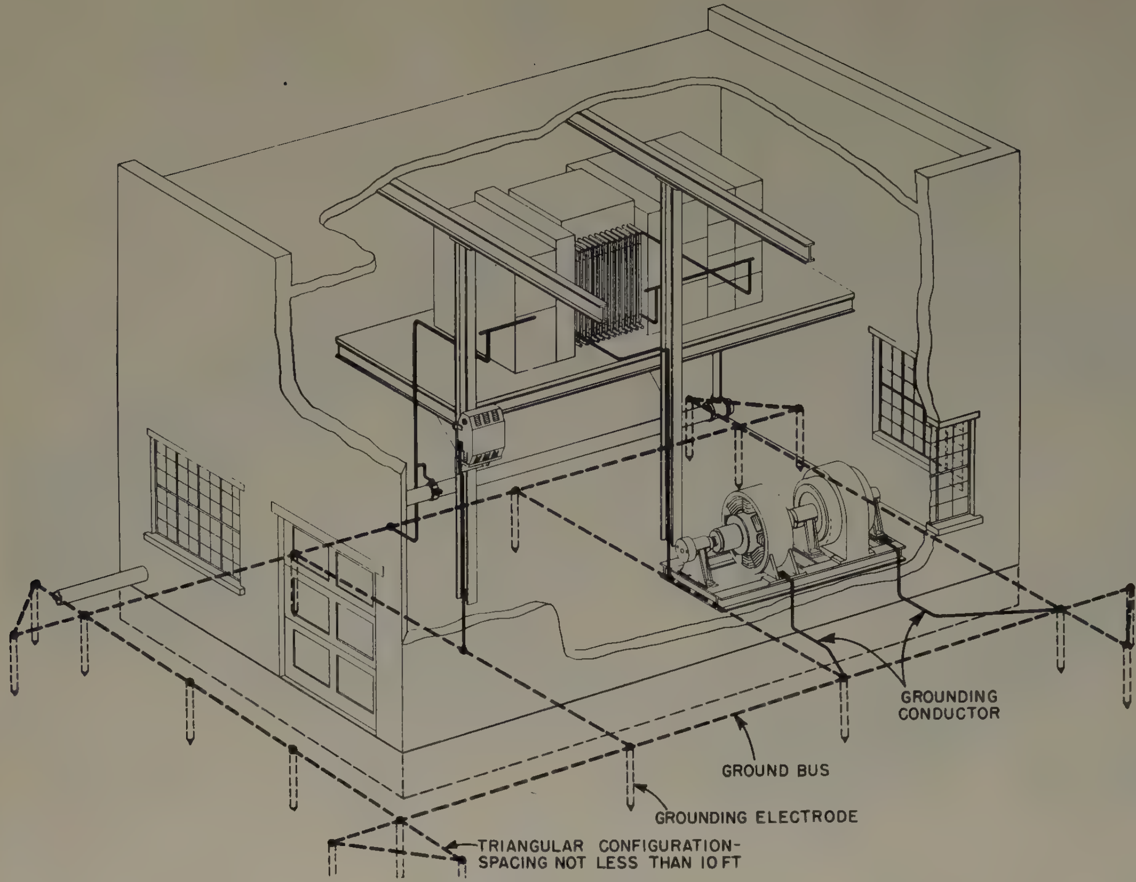

Fig. 3. Typical grounding system for a building and heavy electric apparatus in the building

fatal. The example simply shows that appreciable resistance in the ground return path results in a difference in potential during a ground fault which may be great enough to be fatal to a person stepping or reaching from one point to another.

Fig. 2 illustrates a typical grounding system for an outdoor substation and Fig. 3 illustrates the same for a building. The ground bus is shown surrounding the structure and extending to interior points where building steel or electric equipment or both make it desirable or practical to do so. The ground bus should be connected to grounding electrodes at two or more points and should provide multiple paths to earth from all points so that a single broken connection will not open the path to earth.

Multiple paths for ground fault currents are found to be desirable by experience because ground fault currents seek the lowest impedance return paths and high reactance may be introduced due to separation from the phase conductors. Thus the fault current may not follow the path of lowest resistance, but will seek a path which parallels the phase conductor, such as conduit, cable sheath, or building steel.

Ground bus conductors should be large enough in cross section to carry safely the maximum ground fault current based on the maximum allowable temperature rise. While busses and connections must be braced adequately to withstand the mechanical stresses due to the initial asymmetrical line to ground fault current, the heating effect of such current generally can be disregarded because of its short duration.

Aside from theoretical considerations there are practical limits which finally may determine the maximum or minimum size of ground bus conductors. For mechanical strength the ground bus should not be smaller than No. *2/0* American Wire Gauge (AWG). It usually is not necessary to exceed 500 MCM or equivalent for large generating stations and substations, or No. *4/0* AWG for small stations and industrial plants.

Grounding conductors should be large enough to carry the ground fault current safely. Where the grounding conductor is insulated and run in the same cable or conduit with the phase conductors it should be the same size as phase conductors, and shall be finished to show a green color. This coloring is to distinguish the grounding conductor from the other circuit conductors, but principally from the neutral conductor which shall be white. These two always should be separate conductors even though they may be connected together at the source end. Where the conductor is bare the temperature rise is limited to the same as the ground bus except where exposed to inflammable materials where the total temperature should be limited to 100 C.

RESISTANCE FROM GROUND BUS TO EARTH

It is desirable to keep the resistance from ground bus to earth as low as possible. In actual practice it is sometimes difficult to obtain as low a resistance as might be desired. There is no way of accurately calculating the number of ground electrodes necessary for a particular installation but there are several practical methods of measuring the resistance of electrodes and grounding systems once they are installed. Some of the common methods are the "3-point

method," the "fall of potential method," and the "ratio method." Portable ground-testing instruments provide the most convenient and satisfactory means of measuring the resistance of earth connections.

Some general guides to the desirable values of resistance to obtain for various types of installations are listed here. In all cases the values should be as much lower as can be realized economically.

Large stations	1 ohm
Small substations	5 ohms
Residences	25 ohms

GROUNDING OF POWER STATION AND DISTRIBUTION EQUIPMENT

Applications associated with large apparatus are usually straightforward and tend to fall into familiar patterns recognized by the construction industry. The frames of stationary or permanently located rotating equipment, and the frames and enclosures of static equipment such as transformers and switchgear, should be grounded by direct connection to the ground bus through grounding conductors approximately equal in size to the largest conductor serving the equipment. It is usually neither practical nor necessary to use smaller than No. *6* AWG nor larger than No. *4/0* AWG.

To provide a convenient method of grounding switchgear, a ground bus should be provided as part of the equipment. Usually a 2-inch by $^1/_4$-inch copper bar is used. This switchgear ground bus should be connected to the station ground bus by suitable conductors having a current-carrying capacity equal to that of the switchgear ground bus. In many cases, for example, in metal-clad switchgear or other metal structure, primary apparatus such as current transformers, potential transformers, and power circuit breakers may be considered adequately grounded through their mounting on the structure.

GROUNDING OF STATIONARY UTILIZATION EQUIPMENT

The frames and metallic enclosing cases of all electric equipment and electrically operated equipment not supplied through bus drop cable may be considered adequately grounded if bolted or welded to the steel framework of a structure which has been grounded suitably. If this condition does not exist, an individual grounding conductor should be run from the equipment to the ground bus.

In general, a rigid conduit system is not considered a satisfactory grounding connection. However, on circuits of 600 volts or less, rigid metal conduit made up with fittings, pull boxes, and apparatus housings with fully threaded hubs throughout is accepted as satisfactory by the National Electrical Code.

The frames and metallic enclosing cases of all electric equipment and electrically operated equipment to which power is supplied through bus drop cable should be grounded by running a separate grounding connection from the equipment to the ground bus. Included in this classification is a group which might be considered as semiportable. An example of this group is a machine tool which is not bolted to a building frame, but which is set on a concrete or wood block floor. Unless these machines can be grounded properly by other means, a grounding conductor should be provided in the cable from the plug-in bus to the equipment. Some suggested methods of providing adequate ground connections where this type of distribution is used are outlined as follows:

A 4-conductor bus, with 4-conductor plugs, may be used. In this case the fourth or neutral conductor in the bus is used as a ground instead of a neutral conductor. The method of grounding the equipment is to connect the green ground wire to the case or frame of the equipment at one end and to the stab of the plug which connects to the ground bus at the other. The ground bus in the busway then is connected into the station ground bus at each end of the run.

Three-conductor bus and plugs may be used. In this event it is necessary to exercise some precaution to be assured that a positive, continuous path to ground is provided. Tests on several widely used plug-in busses indicate that with reasonable care a good connection is made through the clamps which hold the plug in position on the bus. Likewise it has been found that the bus housing, when properly installed, provides a satisfactory ground return path. Thus it is only necessary to run a fourth conductor in the bus drop cable and connect it to the equipment frame on one end and the plug case on the other. It also is necessary to provide a positive connection between the bus housing and the steel building frame or the station ground bus. It is evident that the use of this method requires a check from time to time and also some operating instructions to acquaint the personnel involved with the importance of maintaining good ground connections. Further assurance may be attained by providing a separate conductor parallel to the busway, to which the plug may be connected by a jumper each time it is inserted in the bus. Here also a chance is being taken because the operator may not make the connection either through negligence or forgetfulness.

GROUNDING OF PORTABLE EQUIPMENT

Small apparatus and devices present a very serious problem because of their diversity and because they usually are associated with low voltage and relatively small blocks of power which one is inclined to consider as innocuous. The need for proper grounding is even greater on these applications, however, because equipment in this category is used widely by personnel unfamiliar with the potential hazards, and it usually is not so carefully protected. This is emphasized with rather startling clarity by the figures from the Division of Industrial Safety of the State of California. Of the 117 reported injuries attributable to inadequate equipment grounding, 52 were associated with portable electrically operated tools, and 35 more with "cords, plugs, portable extensions, etc." In other words, 87 out of 117, or nearly 75 per cent, were directly related to relatively small, so-called "harmless" devices. Incidentally, 469 out of the total of 577 reported electrical work injuries,

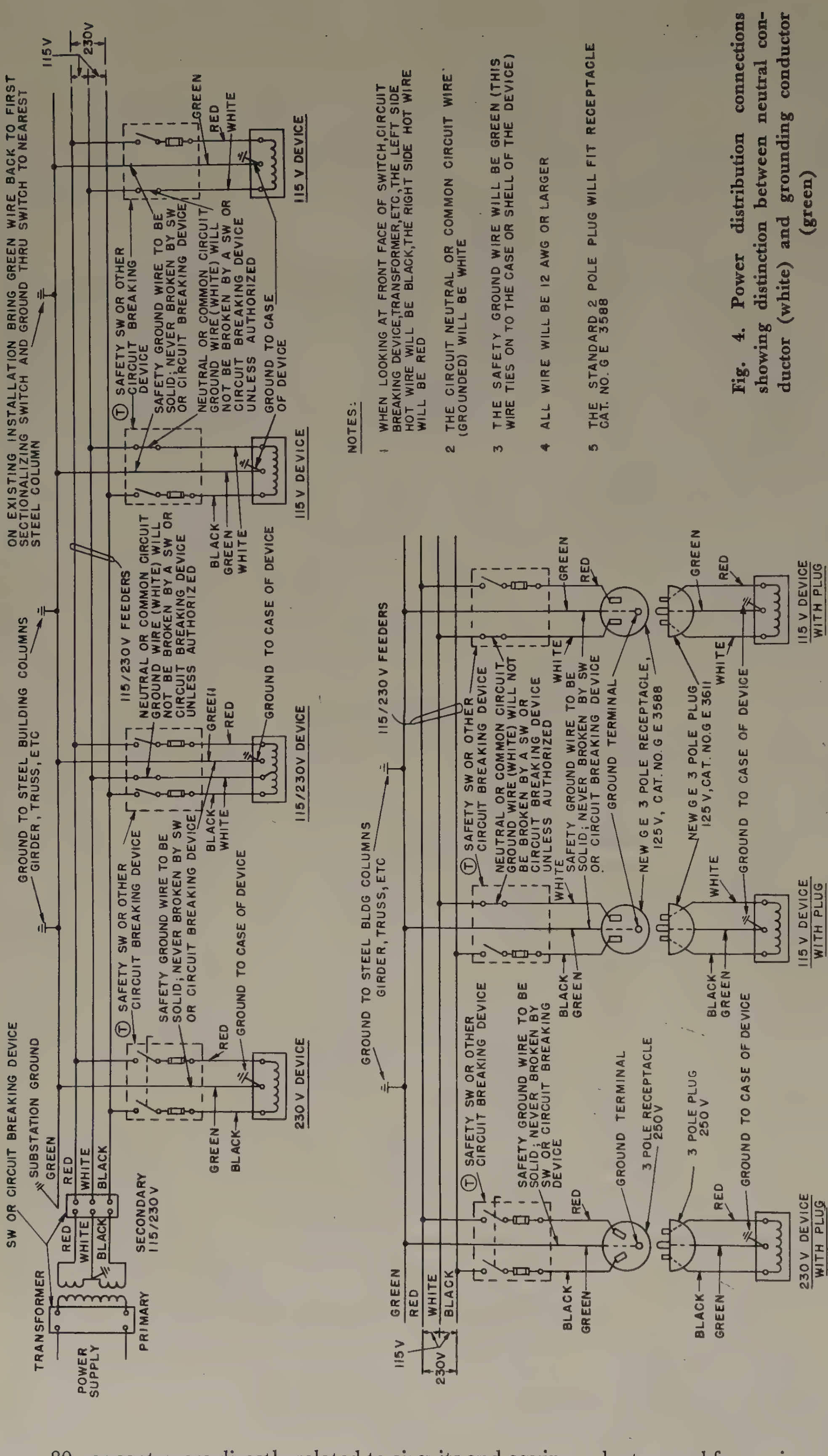

Fig. 4. Power distribution connections showing distinction between neutral conductor (white) and grounding conductor (green)

over 80 per cent, were directly related to circuits and equipment of 600 volts or less.

In many cases where portable tools and equipment are connected through a plug and receptacle, a grounding connection can be made by using special 3-pole outlets with a third, or grounding, conductor in the connecting cable. It is now standard practice in many plants to use only 3-pole outlets throughout the factory area where portable equipment is apt to be plugged in. This has not become an effective solution to the problem as yet, because portable tools often are supplied with a 2-conductor cord and a 2-pole plug, and it is very difficult to convert to a 3-conductor cord and get the third conductor connected to the metallic case of the tool. Furthermore, the 3-pole plug will not enter the conventional 2-pole outlet, which tends to discourage its use until such time as a complete conversion can be accomplished.

Other methods have been used to a limited extent, such as a 3-conductor cord with a clamp-type terminal dangling at the plug end. This method does not present an effective solution because there is seldom a good place to fasten the terminal to ground, and it is too much bother to fasten it even if there is a good place.

There appears to be a trend toward the adoption of the "green" conductor in wiring systems, and the 3-pole plug and receptacle as standard. It even might become a National Electrical Code requirement. However, there are practical objections which must be overcome by education and manufacturing standardization. Electrical engineers can be effective agents in promoting this educational program.

SPECIAL PRECAUTIONS

Although neutral conductors may be grounded at the source, they should not be used for equipment grounding. Separate conductors should be used for neutral conductors and for equipment grounding. Equipment grounding conductors must be identified with green color code to distinguish them from neutral conductors which should be white color code. This requirement is shown in Fig. 4.

Special consideration must be given to certain equipment such as soldering irons, where grounding may constitute a hazard.

Turbine-Generator Controls and Protections

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THE SUBJECTS OF control, protection, and accessories, as related to steam turbine-generator sets, are discussed. These subjects are usually treated on a piecemeal basis of describing either turbine or generator controls alone.

SECTION A: STEAM TURBINES

THE CONTROL SYSTEM of a steam turbine is designed to hold the unit automatically at the desired running conditions and to provide adequate control and complete safety under all imaginable conditions.

The normal governing devices control the unit under normal starting and running conditions. These devices are (*a*) the speed governing system which controls the speed and load of the unit during normal operation and (*b*) the load limiting device which controls the speed of the unit during start up and which may be used to limit the maximum load carried during normal operation.

The pre-emergency control devices take control away from the normal governing devices as soon as certain abnormal conditions exist which, however, are within a safe operating range. These devices are (*a*) the pre-emergency speed governing system which operates the intercept valves on reheat units at moderate overspeed to control the flow of steam trapped in the reheater and (*b*) the initial pressure regulator which partially closes the control valves on accidental decrease in boiler pressure in order to protect the turbine and the boiler from the associated temperature drop. Control of the unit will return automatically to the normal governing devices when the abnormal conditions no longer exist.

The emergency control system protects the unit against unsafe operating conditions and stands as an independent mechanism behind all other control systems. The most important component is the emergency governor which operates at about 110 per cent of rated speed and acts to close all stop valves in steam lines to the turbine. Another component of the emergency control system is the vacuum trip device which acts to close the turbine valves when the condenser vacuum falls too low. An alarm thermostat which also may provide a tripping signal protects against high exhaust hood temperature and a relief diaphragm protects against high exhaust hood pressure. A solenoid trip is provided which will act to close the turbine valves on a remote electric signal. The signal could come either from a remote push button or from protective relays. Those components of the emergency control system which trip part or all of the unit must be reset by hand before resuming normal operation.

SECTION B: TURBINE GENERATORS

NORMAL CONTROLS for generators are those for the hydrogen system, excitation system, and cooling water.

The hydrogen system requires control of gas pressure and purity, and supervision of the shaft sealing oil system.

The excitation system controls generator field current. Control usually is automatic by means of a generator voltage regulator.

Flow of cooling water determines the temperature inside the machine. This flow usually is regulated by hand with cold gas temperature used as a guide.

Turbine generators require protection against burning or damage by internal faults, overheating, hydrogen contamination, and voltage surges from the system.

Protection against burning or damage by internal faults usually is obtained (*a*) by limiting the magnitude of ground fault currents and (*b*) by using high-speed relaying equipment to remove all sources of energy which feed the fault.

Protection against overheating usually is obtained (*a*) by measuring the hot-spot temperatures, (*b*) by using various types of relaying equipments, and (*c*) by operating the generator in accordance with its reactive capability curves.

Protection against hydrogen contamination may be obtained by instruments for supervising pressure and purity and by various alarms in the hydrogen system.

Protection against voltage surges from the system may be obtained by lightning arresters and surge capacitors mounted at the generator terminals. The application of this equipment and the final decision for its use rests with the user.

The subjects of turbine-generator controls, protections, and accessories, cover an ever-broadening field, subject to many variations between manufacturers, and between different customers of the same manufacturer. This paper has attempted to cover the subjects from the viewpoint of the large turbine and generator department of one manufacturer.

APPENDIX

THE CONTROL of cross-compound units must provide the same performance and safety features as that of single-shaft units both when the generators are electrically tied together and when they are separated.

Reheat stop valves are used on most new reheat units. They are a second line of defense against dangerous potential overspeed energy stored in the reheater.

Generator field preheating is recommended for some of the larger machines during all startup periods as a means of extending the life of field insulation and conductors.

Digest of paper 54-40, "Turbine-Generator Controls, Protections, and Accessories," recommended by the AIEE Committee on Power Generation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1954.

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Torque Requirements of a Radar Antenna

MELVIN MARK

Results of wind tunnel tests on an experimental radar antenna are presented. The torque required to rotate the antenna was seen to vary with the azimuth position, the elevation angle, the pivot location, the rotating speed, and the wind velocity. A correlation of the data based on dimensionless parameters was found.

A KNOWLEDGE of the loads imposed on a radar antenna at various wind velocities is important in order to obtain the optimum design for the driving and supporting mechanism. The torque loading in azimuth at various rotating speeds and wind velocities is a function of the position of the center of rotation or azimuth pivot location. Therefore, the engineer designing power drives for radar antennas would like to know the optimum position for the azimuth axis and the torque requirements for this pivot position. An experimental radar antenna was installed for testing in a wind tunnel in order to find the azimuth torque loadings associated with various pivot locations, antenna elevation angles, wind velocities, and rotating speeds. The general results of the testing will be discussed here. Elevation angle as used here will refer to the angle the antenna reflector screen makes with the vertical, positive when the concave face of the reflector points up, negative when down or depressed. Azimuth angle will refer to the angle measured in the direction of antenna rotation from the zero position, zero position being with the concave face of the antenna reflector directed into the wind.

DESCRIPTION OF EQUIPMENT AND TESTS

THE DIMENSIONS of the experimental reflector (a single curvature, parabolic type) were 26 by 84 inches. The reflector surface consisted of an aluminum screen, $^3/_{16}$ inch standard expanded metal. The reflector was mounted on a special plate so that its location, and consequently the location of the pivot in azimuth, could be varied. The plate in turn was mounted on a pedestal incorporating a hydraulic drive, and rotated, turning the reflector. The experimental antenna, Fig. 1, is shown installed in the wind tunnel, elevated to 45°. A pressure-sensitive element in the supply line of the hydraulic drive provided a means for measuring torque. A calibration of the pressure was made by replacing the antenna reflector with a prony brake. Calibration curves were taken at various rotating speeds. For cases where autorotation (i.e., wind turning the antenna) occurred, no measure of the negative torque produced could be obtained, since the hydraulic pressure was not sensitive to this.

The tests could be divided into two groups. In the first, a search was made for the optimum pivot position (i.e., the pivot position in azimuth resulting in minimum peak torques). This was accomplished in a constant wind velocity of 60 mph by varying the position of the reflector on the plate and comparing the torque readings. Rotating speeds of 8, 15, and 25 rpm, and four elevation angles, −13, 0, 22, and 45° were used. The second group of tests consisted of choosing an optimum pivot location and testing over a range of wind velocities from 40 to 100 mph, with rotating speeds of 8, 15, and 25 rpm. Rotation was unidirectional.

RESULTS

TYPICAL of the results of the first group of tests are the curves for 15 rpm shown in Fig. 2 with the reflector at a −13° elevation angle. When the maximum torque occurring in a revolution was plotted against the pivot distance, which is the distance from the bottom center point of the reflector screen to the azimuth pivot measured in the plane of symmetry of the reflector, the results showed that the torque increase varied approximately parabolically with the distance from the optimum pivot. Optimum pivot positions were located for the four elevation angles. At any given elevation angle the optimum position was found to be the same, as closely as could be observed, for the three rotating speeds. With the reflector at 45° elevation the pivot distance for minimum torques was observed to be approximately $^1/_2$ inch; for 22° elevation the distance was 6 inches; at zero degrees the value was 12 inches, and for the reflector depressed to −13° the optimum distance was 16 inches.

The curves of Fig. 2 illustrate interesting energy distributions. It can be seen that as the optimum pivot position (in this case 16 inches) is approached, the torque curve becomes more balanced for this screen type of reflector. For the case of the reflector depressed to −13° in elevation and the pivot 7 inches from the bottom of the reflector screen, the torque curve is quite unbalanced with large torques being required over the last half of the cycle and little or none over the first half. There are two major peaks, one in the region between 180 and 270° in azimuth, the other near 360°. As the pivot point is moved further away from the reflector these peak torques are reduced, but more torque is required over the first half of the cycle. This process con-

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tinues until the peaks become more or less balanced near the optimum pivot point (see curve for pivot distance of 15 inches in Fig. 2). As the pivot point is moved still farther back, a large peak reappears in the torque curve, growing as the distance from the pivot increases. For a distance of 27 inches between pivot and reflector it is seen that the peak torque occurs over the first half of the cycle in the region of 90° in azimuth, and practically no torque is required over the last half. This is the reverse of what occurs on the other side of the optimum pivot point.

In all but two cases the pivot point was varied by changing the horizontal distance from the bottom center point of the reflector screen to the pivot point, keeping the pivot symmetrically located with respect to a horizontal transverse axis connecting the tips of the reflector. For two cases the pivot was displaced or offset from the symmetrical position and the effect on the torque curve noted. It was observed that this changed the location of the peak torque. With no displacement perpendicular to the plane of symmetry of the reflector, the peak torque for the optimum pivot occurred just after 180° in azimuth, a second lower peak occurring in the region before 360 or 0°. By displacing the pivot $1^1/_2$ inches, the peak between 180 and 270° was reduced, at the expense, however, of increasing the peak near 0°. At a 3-inch offset this condition was even more pronounced. Consequently, it was seen that the difference between the peak torques at azimuth angles in the region of 0 and 180° could be reduced by displacing the pivot from the plane of symmetry of the reflector.

Typical of the results of testing at a fixed pivot near the optimum and at wind speeds from 40 to 100 mph are the curves shown in Fig. 3 for a 45° elevation angle.

Fig. 1. Experimental antenna in Wright Brothers Wind Tunnel, Massachusetts Institute of Technology

ANALYSIS OF DATA

THE PROBLEM OF predicting analytically the torque required to turn an antenna at any rotational speed in a given wind velocity is a difficult one. Configuration introduces a high degree of complexity. With antenna torque data available, empirical expressions offer the quickest and most direct solutions to the problem.

The wind tunnel data were correlated on the basis of dimensionless parameters. Consider a family of geometrically similar reflectors with given pivot position and elevation angle. Their size can be characterized by the reflector length or span D and the height H. The other parameters are wind velocity V, rotating speed N, and the density of air ρ (neglecting viscosity and compressibility). Generally, the peak torque occurring during a cycle, T_{max}, is of interest. Applying dimensional homogeneity[1] two dimensionless parameters may be chosen and the relationship written,

$$\left(\frac{T_{max}}{\frac{1}{2}\rho V^2 D^2 H}\right)=f\left(\frac{ND}{V}\right) \tag{1}$$

Let a torque coefficient C_T be defined by

$$C_T=\frac{T_{max}}{\frac{1}{2}\rho V^2 D^2 H} \tag{2}$$

Then equation 1 may be rewritten as

$$T_{max}=C_T\left(\frac{1}{2}\rho V^2 D^2 H\right) \tag{3}$$

and

$$C_T=f\left(\frac{ND}{V}\right) \tag{4}$$

The dimensionless torque coefficient is consequently a function of the rotating speed, wind velocity, and reflector span for a given reflector surface and configuration (i.e., shape, elevation angle, pivot location, back structure, and horn feed).

The data from the tests at an optimum pivot location described here were plotted in the form of equation 1 and the torque coefficient for this experimental antenna determined. The torque coefficient for a pivot in azimuth near its optimum location was seen to vary parabolically with the parameter $\frac{ND}{V}$. The results could be written

$$C_T=K_1+K_2\left(\frac{ND}{V}\right)^2 \tag{5}$$

the dimensionless numbers K_1 and K_2 being functions of the configuration. For 0° elevation and the pivot 11.3 inches

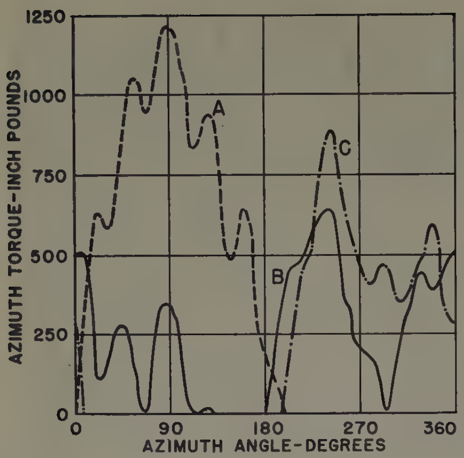

Fig. 2. Torque curves for antenna at −13° elevation, rotating at 15 rpm in a wind velocity of 60 mph. Pivot distance: Curve A—27 inches; Curve B—15 inches; Curve C—7 inches

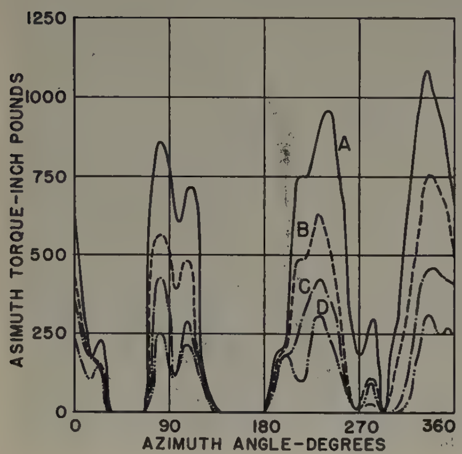

Fig. 3. Torque curves for antenna at 45° elevation, rotating at 15 rpm with azimuth pivot 1.67 inches from reflector. Wind velocity: Curve A — 100 mph; Curve B—80 mph; Curve C—60 mph; Curve D—40 mph

from the screen, K_1 was found to be 0.037. K_1 was the same at −13° elevation and a pivot distance of 14.8 inches. For 22° elevation and the pivot 6 inches from the screen, K_1 was equal to 0.023; for 45° elevation and a pivot distance of 1.67 inches, K_1 was 0.028. For all elevations and the pivot distances mentioned, K_2 was found to have the constant value of 33. The values for the pivot distances given were near their optimum. Consistent units were used in the calculations so that the two parameters of equation 1 were dimensionless. The scatter of the data about the faired parabolic curves was less than 10 per cent.

It might be expected that for a reflector surface, shape, and configuration different from that tested here, equations 3 and 4 still apply, but with the functional relationship of equation 4 to be determined. Consider a change in reflector surface only. A slatted type of reflector surface probably would give results similar to that for the screen surface tested here, for the case where the slats are at 0° angle of attack with respect to the wind and the slat spacing is comparable to the screen opening. As the angle of attack of the slats increases, the surface could be expected to approach the solid type. For a solid type of reflector, the aerodynamic effects may be far more pronounced. For example, let the solid reflector be at an angle near 45° in azimuth. It then is acting in a manner similar to an airfoil, deflecting the air flowing along its surface, which would result in larger pressure forces than for a screen or slatted type. In addition, turbulence is present to a much greater extent. This would mean that C_T should be much greater for the solid reflector.

The effect of configuration on the torque coefficient is, of course, difficult to predict. There are many variables. The back structure certainly influences the pressure forces, tending to make any open reflector surface approach the solid type. The horn feed acts like a fin, affecting the torques in the azimuth regions of 90 and 270°. The optimum pivot location depends upon the configuration. The farther from the optimum pivot position, the higher the torque coefficient. It was seen that the optimum pivot location varied with the elevation angle for the experimental antenna tested. As the reflector was elevated and approached a more symmetrical body, the optimum pivot location moved closer to the reflector surface.

In time, as more data become available, the precise effects of these many variables may become apparent and more accurate generalizations made. The considerations presented here are offered as an addition to the fund of experience for future design work.

CONCLUSIONS

1. The optimum pivot point (or center of rotation) of a radar antenna for azimuth torques gives more uniform torque requirements besides giving minimum peak torques. The farther from the optimum, the more unbalanced becomes the torque curve, plotting torque versus azimuth angle, (i.e., large torque required over one-half the cycle, little or none over the other half) and the larger the peaks.
2. As the antenna elevates and presents a more symmetrical body, the optimum pivot location moves closer to the reflector.
3. The increase in peak torque over that at the optimum pivot location varies approximately parabolically with the distance from the optimum point.
4. The antenna torque curves for a screen-type reflector surface with given back structure and horn feed has major peaks in three azimuth regions: near 90°; a little after 180° (often between 180 and 270°); and in the region before 360°. Which of these peaks becomes the largest depends upon the pivot location. When the pivot is near optimum the torque curve is well balanced and consequently the peaks are approximately equal. On one side of the optimum location the peak at 90° becomes the largest. On the opposite side the peaks in the region of 180° and 360° predominate. In this latter region pivot offset is an important factor in increasing or decreasing the peak between 180 and 270° at the expense of that at 360°. For a slatted-type reflector surface with slats at 0° angle of attack the results should be similar. For a solid reflector surface, the peak torque probably will be in the azimuth region near either 45° or 270°.
5. Equation 3 gives the general type of relationship found to exist between maximum torque, wind velocity, and rotating speed for an experimental radar antenna in wind velocities from 40 to 100 mph.

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1. Advanced Dynamics (book), **S. Timoshenko, D. H. Young.** McGraw-Hill Book Company, Inc., New York, N. Y., 1948, p. 381.

INSTITUTE ACTIVITIES

Largest Winter General Meeting Program Sets Record for Greatest Attendance

During the week of January 18–22, 1954, the largest Winter General Meeting program in the history of the Institute took place with headquarters in the Hotel Statler. Altogether 183 *Transactions* papers and 230 conference papers were presented in 95 technical sessions. Over 100 committee meetings were also held during the week. Overflow sessions were in the Hotel McAlpin. The smoker was held at the Hotel Commodore on Tuesday evening and the dinner-dance in the Ballroom of the Hotel Statler on Thursday evening. A number of inspection trips to places of interest in the city and vicinity were arranged during the days and theatre tickets to popular shows were made available to out-of-town members. The total registered attendance was 4,958, which represents a 6 per cent increase in the record attendance of 4,676 for the previous year. The attendance at the Winter General Meetings over the past five years is shown in Table I together with the membership growth and the number of papers presented each year. Excellent arrangements were made by the Winter General Meeting Committee under the chairmanship of C. T. Hatcher.

LADIES' ENTERTAINMENT

Starting with a get-acquainted tea on Sunday afternoon, an interesting series of social events and trips were arranged by the Ladies' Entertainment Committee under the chairmanship of Mrs. E. S. Banghart. The U. S. Naval Shipyard was visited with luncheon in the officer's club as well as a visit to the *S. S. Santa Rosa*. Trips were made to Steinway and Sons, the United Nations, and Lever House. There was a breakfast at Altman's with a lecture on interior decoration, as well as a luncheon and fashion show, and a dinner with entertainment and door prizes on Tuesday evening.

GENERAL SESSION

AIEE President Elgin B. Robertson, president, Elgin B. Robertson Inc., Dallas, Tex., presided at the General Session on Monday afternoon, January 18. In his introductory address, "30 Years of Institute Technical Progress," Mr. Robertson discussed the evolution of the technical activities of the Institute. He pointed out that despite the ever-increasing variety of problems

Table I. Membership Growth; Number of Papers Presented and Attendance at Winter General Meetings During Past Five Years

Year	Membership as of Jan. 1	Per Cent Increase	No. of Sessions	No. of Papers	Per Cent Increase	Registration	Per Cent Increase
1950	34,008		56	246		3,212	
1951	38,171	12.2	62	300	22.0	3,334	3.8
1952	42,471	11.3	69	280	−6.6	3,925	17.7
1953	45,443	7.0	88	400	43.0	4,676	19.2
1954	47,710	5.0	95	413	3.2	4,958	6.0
Over 5-year period		40%			68%		54%

An invitation to attend the Middle Eastern District Meeting in Reading, Pa., October 5–7, is tendered by Vice-President W. B. Morton to visitors to the District 2 exhibit at the Winter General Meeting. Marie Buffone (left) and Joan Kuver are dressed in the quaint Pennsylvania Dutch costume of that region

Future AIEE Meetings

Conference on Rubber and Plastics
Mayflower Hotel, Akron, Ohio
April 5–6, 1954
(*Final date for submitting papers—closed*)

Southern Textile Conference
A. French Textile School of Georgia Institute of Technology, Atlanta, Ga.
April 15–16, 1954
(*Final date for submitting papers—closed*)

Conference on Feedback Control
Claridge Hotel, Atlantic City, N. J.
April 21–23, 1954
(*Final date for submitting papers—closed*)

AIEE-IRE-RETMA-WCEMA Electronic Components Conference
Washington, D. C.
May 4–6, 1954
(*Final date for submitting papers—closed*)

North Eastern District Meeting
Van Curler Hotel, Schenectady, N. Y.
May 5–7, 1954
(*Final date for submitting papers—closed*)

Appliance Technical Conference
Morrison Hotel, Chicago, Ill.
May 17–19, 1954
(*Final date for submitting papers—closed*)

Electric Welding Conference
Milwaukee, Wis.
May 19–21, 1954
(*Final date for submitting papers—closed*)

AIEE-IAS-IRE-ISA Conference on Telemetering
Morrison Hotel, Chicago, Ill.
May 24–26, 1954
(*Final date for submitting papers—closed*)

Summer and Pacific General Meeting
Biltmore Hotel, Los Angeles, Calif.
June 21–25, 1954
(*Final date for submitting papers—March 23*)

Petroleum Technical Conference
Tulsa, Okla.
September 27–30, 1954
(*Final date for submitting papers—June 28*)

Middle Eastern District Meeting
Abraham Lincoln Hotel, Reading, Pa.
October 5–7, 1954
(*Final date for submitting papers—July 7*)

Fall General Meeting
Morrison Hotel, Chicago, Ill.
October 11–15, 1954
(*Final date for submitting papers—June 14*)

Machine Tool Conference
Detroit, Mich.
November 8–10, 1954
(*Final date for submitting papers—August 8*)

1955 Winter General Meeting
Hotel Statler, New York, N. Y.
January 31–February 4, 1955
(*Final date for submitting papers—October 20*)

J. F. Peters (second from left) receives the Edison Medal for 1953 from AIEE President Robertson during ceremonies at the Winter General Meeting. Looking on are A. C. Monteith (left) who outlined Mr. Peters' career and Past President J. F. Fairman (far right), chairman of the Edison Medal Committee

facing the AIEE, its most important function is still its technical activity. The full text of Mr. Robertson's remarks appears on pages 197–8 of this issue.

Edison Medal Presentation. A feature of the General Session was the presentation of the Edison Medal to J. F. Peters, consulting engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa., "for his contributions to the fundamentals of transformer design, his invention of the Klyndonograph, his contributions to military computers, and for his broad understanding in the training of young engineers." In accepting the award, Mr. Peters spoke of the obligation of the older engineers to their juniors and said that older engineers "must appreciate that we have a precious privilege to prepare our engineering youth for the promising engineering future that lies ahead."

Highlights of Mr. Peters' life were given by his associate, A. C. Monteith, vice-president in charge of engineering, Westinghouse Electric Corporation, and the history of the medal was outlined by J. F. Fairman, vice-president, Consolidated Edison Company of New York, Inc., and chairman of the Edison Medal Committee. The Edison Medal addresses are presented in full on pages 215–17.

Institute Paper Prizes. Chairman E. I. Green of the AIEE Committee on Award of Institute Prizes described the basis for these awards and announced the winners. First prize for the Best Student Paper went R. K. Baird, South Dakota School of Mines and Technology, for "Some Observations of a Liquid Dielectric Stressed by High Voltage to the Point of Breakdown"; second prize to Richard Farrelly, Manhattan College, "Transient Response of the Saturable Reactor as Applied in Industrial Waste Precipitation."

Institute prizes, awarded on a Division basis, were as follows:

Communication Division. First prize, A. C. Keller, Bell Telephone Laboratories, Inc., "New General-Purpose Relay for Telephone Switching Systems"; second prize, A. B. Clark, Bell Telephone Laboratories, Inc., "The Development of Telephony in the United States."

General Applications Division. First prize, C. H. Jones, Chicago, South Shore and South Bend Railroad, "An Interurban Becomes a Railroad"; second prize, R. L. Hurtle, General Electric Company, "Controlling D-C Arcs."

Industry Division. First prize, C. E. Miller, General Electric Company, "Voltage Rating Versus Horsepower of Synchronous and Induction Motors"; second prize, F. Berra, D. B. Carson, C. A. Poppino, "A-C Distribution in Open-Pit Copper Mines."

Power Division. First prize, C. Nichols, Leeds and Northrup Company, "Techniques in Handling Load Regulating Problems on Interconnected Power Systems"; second prize, P. L. Alger, R. F. Franklin, C. E. Kilbourne, J. B. McClure, General Electric Company, "Short-Circuit Capabilities of Synchronous Machines for Unbalanced Faults."

Science and Electronics Division. First prize, E. P. Felch, Bell Telephone Laboratories, Inc., and J. L. Potter, Rutgers University, "Preliminary Development of a Magnettor Current Standard"; second prize, A. J. Williams, Jr., J. F. Payne, Jr., "A-C Null-Type Recorder With Balancing Amplifier Which Provides Damping and Suppresses the Quadrature Component."

Siemens' Letters Presentation. E. S. Dean, representing Sir George H. Nelson, presented a volume of the Letters of Sir William Siemens to the library of the AIEE. Sir William was the first president of the Institution of Electrical Engineers (Great Britain) and a pioneer of the steel industry.

Keynote Speaker. Vice Admiral Harold G. Bowen, U. S. Navy (Retired), executive director of the Thomas Alva Edison Foundation, West Orange, N. J., in his role as keynote speaker discussed "The Genesis of the Electric Light and Power Industry." In his address, Admiral Bowen stressed the development of the electrical industry with reference to the 75th anniversary of electric lighting, the role of Thomas A. Edison in this development, and the 50th anniversary of the founding of the Edison Medal. He considered some of the important inventions which have played a part in the growth of the electric light and power industry and paid tribute to the Edison Medalist for 1953, J. F. Peters, for his contributions to this growth.

TECHNICAL PROGRAM

The subject matter of the technical sessions ranged throughout all five broad divisions of Institute technical activities—communication, general applications, industry, power, science and electronics—besides five of the general committees' sponsored technical sessions.

General Committees. Four sessions were sponsored by the general committees on management, safety, research, and education.

The papers in the management session had to do with a development program for managers in medium-sized organizations and the opportunities for engineers today in the field of management. The safety session presented papers from the point of view evaluating the factors affecting permissible leakage currents in portable electric equipment. Starting with a paper on the threshold of perception currents, other papers were from the viewpoints of the electrical manufacturer, the electrical utility, and the electric equipment merchandiser. Five papers on research in the power field dealt with the principles of operations, research and applications, research in the development of atomic fuels for power generation, the need for more research in the electric power industry, and the educational point of view of the student.

The desires of industry, the degree to which electronics should be stressed, how specialized such training should be, the effects of recent scientific developments, and the pros and cons of the 5-year curriculum were discussed in the session held on electronic education.

Educators should be slow to change the subject matter of courses to conform with the transitory wishes of industry. Too much government-sponsored work as a substitute for basic research, and confusion between equality of opportunity and equality of ability should be eliminated.

The idea that the knowledge presented to undergraduates should be broad was criticized; a discusser held that more specialization was needed to make the student cognizant of the extent of his ignorance. Undue emphasis is placed now on the glamour field of electronics, causing problems which could be simply solved mechanically to be expensively attacked by elaborate electronic means, another discusser expressed at this session.

Communications Division. Many of the sessions in this division were devoted to the latest developments in television and allied fields.

Continuous operation of new facsimile scanners and recorders were described at the session devoted to the transmission and reception of facsimile signals. A progress report on a new continuous feed scanner consisting of two rotating disks with different spirals and a slot which can be used with various optical systems in a variety of applications was presented by John V. L. Hogan. This spiral method can be applied equally well to scanning 18-inch-wide copy and 35-mm film.

Thirteen papers covered television in general, of which eight were devoted to color television networks, measurements, and transmitting facilities. One of the major problems is the intercity distribution of color television signals because the existing monochrome networks must be reconditioned for color transmission. New techniques and instruments are being developed,

both to modify existing network characteristics as required for color, and to measure and adjust the resultant characteristics.

Another phase of color television transmission was covered in the four papers on cameras and other studio equipment and its operation. Basically the procedures for operating studio equipment for monochrome and color television are similar and when the correct relationship of the elements has been established, operations can be carried out by adjusting common controls which affect all three color channels simultaneously.

The five papers in a third session were devoted to television antennas, the use of klystron power amplifiers in a uhf transmitter, and a community television system.

The remote control of aural broadcast stations presents many technical problems to the operator; he must not only control the actual broadcast facilities and the resultant signal, but also the supply voltages for the transmitter, lighting of warning lamps on towers, and so forth, and he must know also at all times just how everything is functioning. It was found that ultrasonic tones superimposed on the FM program material supplied the necessary links without deterioration of program quality.

Two such papers on remote broadcast stations were given in a session in which the design of very small broadcast receivers and a new type of vertical sync circuit for television receivers also were considered as well as the torque requirements of a radar antenna.

General Applications Division. Land and marine transportation, illumination, and heat pumps were the subjects covered in the six sessions of this division.

Nuclear power plants for ship propulsion were considered in two papers in the marine transportation session, one dealing with a general description of such a system and the other with its economic aspects. A very interesting historical paper dealing with electrical installations on tankers and how they had developed in the course of 40 years was given by L. M. Goldsmith, Atlantic Refining Company.

In the case of vessels making relatively long voyages the use of a-c diesel-electric drives is more efficient and economical, but in ships which are maneuvering and operating almost continuously under varying conditions of loading, direct current has almost ideal characteristics. Whether the d-c system should be connected in parallel or series was discussed by J. A. Wasmund, Westinghouse Electric Corporation.

Group replacement of lamps and intraplant versus contracted maintenance programs were discussed at the session on "controlling the elusive lumen."

Cost-analysis formulas and charts enabling a company to determine if group replacement would be profitable were presented. One plant, which uses almost 50,000 fluorescent lamps, reported that group replacement, using their own employees after hours, has worked well in practice. Another company, however, found that until they employed an outside contractor, they could not keep up with burnouts.

The largest contractor, who services more than 11,000 installations on a nongroup-replacement basis, has evidence that it is more economical to employ such concerns, whose specialists can do each task much more efficiently than inexperienced help.

Industry Division. In this division, 17 different sessions were held in the fields of the chemical industry, electrochemical processes, mining and the metal industries, and the related industrial control problems. One session was devoted to electric regulators for industrial machines in which their characteristics and economic fields of applications were considered. A report on industrial power systems grounding was presented in four parts from the aspects of system neutral grounding, equipment grounding, static grounding, and grounding for lightning protection and earthing. Three sessions were held on feedback control systems and another on electronic control.

An application of the principle by which the common housefly is supposed to maintain its balance was a feature of one of the feedback control sessions. Theoretical servomechanism studies also were presented.

The Gyrotron vibratory rate gyro maintains an inertial angular-velocity reference by means of a tuning fork which is electromagnetically driven. The device is reported to have a near-infinite life.

The sinusoidal-response method of studying contactor servomechanisms employing sampled data allows the evaluation of self-sustained oscillations and critical values to be determined. The describing-function method allows such nonlinear effects as saturation, hysteresis, overloading, and backlash to be evaluated.

The subject of electronic control was approached from the aspects of performance specifications, photoelectric inspection applications, and an electronic variable-frequency power supply.

A manufacturer often has to guess if all pertinent specifications for a product have been supplied by his customer; this is partly caused by ambiguities in the present electronic control definitions. Committee work is now in progress to remedy the confusion.

Diverse applications of the phototube in completely automatic electronic controls for industry include registration of plates and dies, inspection of casings, and detection of impurities. For industries requiring discrete motor speeds, an electronic power supply has been developed which has greater versatility than motor-generator sets.

Power Division. Faster relaying time has been achieved by the employment of an all-electronic carrier relaying system. Four papers on the subject were presented from the following points of view: reduced fault clearing time, over-all operating principles, the relay operating principles, and the performance evaluation of the relaying equipment. A second session on relaying dealt with such subjects as loss of field protection for synchronous machines, an improved transformer differential relay, setting of industrial relays, and single-pole reclosing.

Beginning with the elementary principles of matrix algebra and general network theory in terms of matrix algebra with applications to the analysis of rotating machinery, various aspects of the subject were covered in nine sessions in this field. Subject matter presented dealt with commutation and carbon brushes, the cooling of large synchronous generators, as well as vibrations, temperatures within the windings, and winding arrangements. Papers in three other sessions on rotating machinery embraced the theory, design, operation, and performance calculations of induction motors.

In the field of power generation, the first session was devoted to papers on the magnetic amplifier or "Magamp" and amplidyne regulators.

The feature of the second session was a paper which treated the difficult economic, engineering, and financing problems of the Ohio Valley Electric Corporation project to supply the gaseous diffusion plant known as the Portsmouth area of the Atomic Energy Commission with 1,800,000 kw and 15 billion kwhr per year. This is the largest single-power contract ever entered into by a single customer and with provision for cancellation at any time from the date of execution until termination requiring an expenditure of over $400 million. The entire project, with its many difficult problems of sites, fuel supply, rights of way, engineering planning and design, and regulatory approvals and the speed with which it was done is a great tribute to modern engineering. In the studies, a very modern network calculator was kept busy on two shifts for more than 6 months. The circuit breakers alone presented difficult problems as the size and capacity required never had been designed before and it was considered a tribute to engineering in this country that two manufacturers could design and build 330-kv 25-million-kva breakers on short notice.

Other papers in this session dealt with hydroelectric projects and operating experiences with such projects.

Sessions were jointly held with the Committee on System Engineering in which papers were presented on the control and protection of steam turbine units as well as methods of starting gas turbine-generator units, communication systems, telemetering, and load frequency control. In another session on system engineering, interesting papers were presented on methods of computing the incremental transmission line losses for the determination of power system economic balance as well as a description and application of the penalty factor computer.

In power transmission field, an entire session was devoted to extra-high-voltage transmission systems. Papers were presented which dealt with the design principle and electrical characteristics and performance of the American Gas and Electric Company's 330-kv transmission system as well as the equipment. Protective practices as a criterion for high-voltage transmission design was the subject of another paper. A report on insulation co-ordination also was presented and in the session on substations, three working groups presented guides on minimum electrical clearances for standard basic insulation levels, methods of substation grounding, and safety considerations in the design; 330-kv outdoor station design, and switching surge voltages in high-voltage stations were the subjects of other papers in the session on substations.

An entire session on switchgear was devoted to the new 25-million-kva 330-kv circuit breakers as well as 330-kv air switches and disconnects, dielectrics, and other associated design problems. Some of the

papers in other sessions on switchgear concerned the lower voltage breakers, the hydraulic and pneumatic mechanisms, a guide for application and operation of outdoor metal-clad switchgear, a new basis for rating power circuit breakers, and a guide for the ice testing of outdoor disconnecting switches.

Science and Electronics Division. Three sessions were held on Dielectric Standards, including those under discussion by international committees. Three sessions on semiconductors also were held, one on various phases of transistor development, including materials and devices, and two on selenium and tellurium, their basic properties and their use in rectifiers. The magnetic sessions were on the relation of fundamental physical properties to the use of magnetic materials (especially ferrites) in apparatus, with special reference to domain structure and magnetostriction. A conference on sources of electrical noise and means of dealing with them was conducted successfully by the applied mathematics groups. One session was organized on the synthesis and response of electronic circuits.

One of the outstanding papers presented at the session on medicine and biology was a description of a sealed-off donut for electron beam production. It was stated that radiation treatment of tumors with this apparatus is better than with X rays because damage to underlying tissue is greatly minimized.

Another paper of this session was a description of the various types of X-ray tubes which have been made available for radiobiology.

The advent of television broadcasts at uhf has brought about the development of new tubes for both transmitters and receivers. At a session devoted to this subject, a group of klystrons was described, both air- and water-cooled, one having an output of 200 kw. Another paper dealt with a series of "pencil" tubes especially designed for uhf television receivers.

Four papers were presented at a session devoted to infrared transducers. In one of these, infrared detectors were described and their applications explained in observing photographic processes in the darkroom, the actions of living specimens in the dark, astronomical uses, and so forth.

Several types of transistors were described in the session on semiconductor devices. A motion picture was shown on the newly developed surface-barrier transistor and its functioning was explained. It was stated that other types of transistors can be made employing this same system, which is still in the developmental stage.

In the session covering electrostatic processes, the theory and design of electric-spark machine tools were explained in the opening paper and the other four papers were on electrostatic precipitation, two of these dealing with the power supplies for precipitators.

A highlight of the magnetic materials meeting was a talk on recent magnetic research in Japan. Domain theory and magnetostriction also were discussed.

The Japanese, who developed the first commercial use of ferrites and started the research that led to the Alnico series of alloys, are engaged now on new research and applications of ferromagnetism.

The design of low-noise equipment using grain-oriented silicon steels and nickel-iron alloys is dependent on the reduction of external stresses and internal strains. By keeping the material under tension, these forces may be reduced.

A conference on noise was held in which papers on the theoretical and practical aspects of noise, as well as on applied mathematics, were presented.

The types of noise were analyzed as to their cause, nature, and magnitude. It has been found that detection over video bandwidths ideally requires the use of a "quadradic form detector"; unfortunately, this device has not yet been invented, except mathematically.

The application of Green's function to the solution of time-varying electromagnetic fields should help to close the conceptual gap between circuit and field theory. An application of the wave-mechanical method to sinusoidal linear time-varying circuits simplifies their solution.

The conference on selenium and tellurium was concerned with the electrical properties of these anisotropic semiconductors in their liquid, single-crystal, microcrystalline-colony, and equiaxed forms, especially as applied to the improvement of selenium rectifiers.

Surface states, microstructures, diffusion, and the effect of thallium were discussed. A model of the selenium and tellurium hexagonal-structure crystals was proposed.

Eddy currents, atmospheric electricity, energy flow, and the electric arc were discussed at the session on basic sciences. The extension of the linear theory of alternating fields in ferromagnetic materials to include saturation effects should do much to explain the deep penetration of eddy currents.

Eddy currents in extended structures caused by nearby alternating currents were mathematically evaluated.

A potential-measuring instrument, using the null and substitution method, in connection with a radioactive probe and electronic pulse widener and voltmeter, has been developed. The flow of energy in an idealized 3-phase alternator, and the properties of a high-current d-c arc in argon also were described. A discusser believed that the gas through which the arc jumps has a far greater effect on it than the electrode material.

Recent developments in the measurement of electricity and the extension of the present range of instruments were described at the instruments and measurements session. The first successful commercial tungsten resistance thermometer, presently usable from −200 to +300 C, and stable to over 1,000 C, has been developed. A low-impedance thermocouple-type ammeter is now available with a range of 0 to 200 megacycles.

Electric-energy measurements on watthour meters now may be made to better than 0.06-per-cent accuracy by a comparison method utilizing photoelectric counting and electronic control. The elimination of current-induced torque in the moving-coil of the a-c galvanometer by the addition of series reactance has been confirmed theoretically and experimentally.

In the electronic power converter session, "Rectifier Arc-Back Study on the Analogue Computer" was given by J. K. Dillard and C. J. Baldwin, Jr., Westinghouse Corporation. The paper should prove of great assistance to designing and application engineers in solving fault current problems connected with power rectifiers.

The two conference papers—the first, "Pumpless Ignitrons—Field Experience and New Developments" by R. J. Moran and E. J. Remscheid of General Electric; and the second entitled, "Methods of Measuring Arc Drop Voltage on Mercury-Arc Rectifiers" by H. Winograd of Allis-Chalmers and W. E. Lawton of Aluminum Company of America—drew both formal discussion and general oral question and comment. More conference papers on the methods of measuring arc drop voltage on mercury-arc rectifiers are needed to assist the committee on electronic power converters in deciding whether the approved method should be changed, and if so, which alternative method should be adopted.

Abetti, Jacobs, and Kegel Honored at Eta Kappa Nu Recognition Dinner

Pier A. Abetti (AM '49) of the Power Transformer Engineering Division, General Electric Company, received the Eta Kappa Nu Award for the outstanding young electrical engineer of 1953 at the Annual Recognition Dinner held on January 18. Honorable mention was awarded to Dr. John E. Jacobs of the General Electric X-Ray Research Laboratories in Milwaukee, Wis., and to A. G. Kegel (AM '48) of the Air Arm Division of the Westinghouse Electric Corporation in Baltimore, Md.

Dr. W. R. G. Baker, Dr. M. J. Kelly, and Dr. Reinhold Rudenberg were elected to Eta Kappa Nu as eminent members and were introduced by Dr. J. E. Hobson. Dr. Kelly, who responded on behalf of the eminent members, paid tribute to the work of Eta Kappa Nu in its recognition of outstanding young electrical engineers.

The ceremonies were opened by Dr. Eric T. B. Gross, national president, who extended a cordial welcome to members and guests attending the dinner. V. L. Dzwonczyk acted as master of ceremonies for the occasion.

A. F. Van Dyck of atomic energy fame, who is with the Sheffield School, Yale University, called attention to the critical state of the nation brought about by technical progress and the impact of nuclear knowledge. It is now more necessary than ever to be careful he said, pointing out that Hitler was able to pervert a nation through the press, radio, and propaganda in 6 years. Dr. Van Dyck reminded his audience that the Eta Kappa Nu awards take cognizance of not only technical progress but the humanities as well. In conclusion, he expressed the hope of always having men of

Left to right: Dr. Eric T. B. Gross, national president of Eta Kappa Nu, with three newly elected eminent members, Dr. Reinhold Rudenberg, Dr. W. R. G. Baker, and Dr. M. J. Kelly, and Dr. J. E. Hobson, national vice-president of Eta Kappa Nu

the qualities and leadership of those being honored this year.

AWARD WINNER

Dr. Abetti, who received the 1953 Recognition Award "for his original approach to power transformer design through the creation of unique electromagnetic models and his exceptional civic and cultural attainment," was born in Florence, Italy, and his father was the director of the Florence Observatory. Early in life he had shown interest in many scientific fields including astronomy, mineralogy, and botany, as well as in languages and literature. He came to the United States in 1946 and during the next 2 years obtained his master of science degree in electrical engineering and completed his academic work for the doctor of philosophy degree at Illinois Institute of Technology. Achievements during the past 5 years were outlined by Dr. Gross who drew attention to Dr. Abetti's civic and literary contributions to the *Berkshire Eagle* as well as his technical work in the creation of the unique electromagnetic model of a transformer for which he received the Coffin Award in 1952. The citation was presented to Dr. Abetti by the Honorable Joseph B. Cavalaro of the Italian Historical Society of America and in response Dr. Abetti spoke of the pleasures of development engineering and the pleasure of seeing the results of getting things done.

HONORABLE MENTION

Dr. John E. Jacobs received the 1953 Honorable Mention Award "for his outstanding discoveries in the application of X-ray methods to industrial problems and his interest in cultural and social activities." He became a radio amateur at the age of 13 and was a radio man third-class in the U. S. Navy in 1942. He was graduated first in his class of 1,300 at Columbia University and was commissioned an ensign and served in the Pacific as gunnery officer and radar officer on the *U. S. S. Nicholas* from 1943 to 1946. After his service in Korea, he received his bachelor of science degree in electrical engineering in 1947, his master of science degree in 1948, and his doctor of philosophy degree in 1950, all from Northwestern University. His career was outlined by Dr. J. F. Calvert who also mentioned particularly his ability as a speaker, his activities in the Parent-Teachers Association, his interests in music, his work and the applications of cadmium-sulphide crystals for X-ray detection for which he received the Coffin Award.

Adam G. Kegel was awarded 1953 Honorable Mention "for his distinguished contribution to the design of autopilots and fire control systems and his unselfish work for his church and the youth of his community." Early in his career, he built model airplanes and boats and in 1944 he served with the U. S. Naval Reserve where he installed and maintained the electronic equipment aboard 12 ships. This included radar, loran, radio transmitters, and radio receivers, as well as auxiliary rotating machinery and the intercommunication systems. Returning to Northwestern University after his naval service, he received a bachelor of science degree in electrical engineering in 1947; he received his master of science degree in electrical engineering from the University of Pittsburgh in 1949. Immediately after graduation, he joined the Westinghouse Electric Corporation where he was responsible for many achievements in feedback control engineering in connection with the development of servo systems for positioning air-borne radar antennas and gun turrets. His career was outlined by N. V. Petrou, who also called attention to his teaching and leadership qualities as well as his church activities. In response, Mr. Kegel attributed his inspirations to the faith and loyalty that men have in each other.

Members and guests attending the dinner were entertained through the courtesy of the General Electric Company with a demonstration of electrophysical phenomena, "Magic Versus Science," effectively presented by W. A. Gluesing.

Sections Committee and Representatives Discuss Operational Procedure

Many aspects of Section activities were discussed in an informal meeting of members of the Sections Committee and Section representatives which was held on January 19. The meeting was opened by the presiding officer, W. R. Hough, chairman of the Sections Committee, who explained that the informal meeting was exploratory in nature with a view toward determining subjects for the agenda of the Section Delegates Conference to be held during the 1954 Summer and Pacific General Meeting in Los Angeles, Calif.

MEMBERSHIP

The chairman of the Membership Committee, Charles Clos, announced that the membership had reached a new high of 47,710 as of January 1, with only 1,051 delinquents. However, student enrollment had declined since May 1, 1950, from a high of over 20,000 to only 5,998 enrolled students as of January 1. Serious concern was expressed over the lost student enrollment. It was suggested that delegates discuss the matter with their local membership committees to see what may be done to remedy the situation.

In discussion, the chairman of the Committee on Student Branches explained that the President had met with the Vice-Presidents and they had been asked to do everything possible to stimulate student enrollment. In the fall, a folder relating the advantages of student enrollment is circulated and recently another leaflet has been issued listing 14 practical ways for students to advance in the electrical engineering profession. Hope was expressed that the Sections would assist the Student Branches by providing good speakers, and that a close tie should exist between the Sections and the Student counsellors. Personal contact was deemed essential. The desirability of advising speakers in advance that they should not be too technical when addressing students also was pointed out. Another view drew attention to the fact that some Branches have large local memberships which are not known at Institute headquarters; these local members should be followed up on graduation and encouraged to attend the Section meetings.

In conclusion, President Robertson expressed the opinion that the Student Branch counsellors hold the answer to the problem as the students look to them for guidance since many are undecided about what they should do. If members do not show that they are concerned about the problem, Mr. Robertson questioned, how can it be expected that the counsellors will be concerned? Student activities in the District quite often have more damage done by one speaker in the fall than can be undone in 8 months and thus it is very important to have the best people speak to the students in the right way.

PROFESSIONAL RECOGNITION

In view of the recent growth of labor organizations and the threat to the development of a true engineering profession, C. C. Herskind, chairman of the Schenectady Section, expressed the views of the Section Executive Committee on the matter and in-

troduced a resolution. No particular plan for professional development was proposed but the Section requested that AIEE persist in efforts to develop a program for unity and professional development. After amendment the resolution was carried by 19 affirmative votes to none as opposed. The amended resolution reads as follows:

"Resolved, that since it is the policy of the Institute, as affirmed by the Board of Directors statement of June 15, 1950, to work continually for the unification of the profession and since actions are pending in National and State Legislatures which may restrict the development and unification of the engineering profession, we, the Sections representatives, urge the Board of Directors to vigorously continue efforts to find an acceptable basis for unity of the profession."

TRANSFERS

The procedure for transfers work was described by E. P. Yerkes, chairman of the Transfers Committee, who explained that one of the objectives was to have each member in the highest grade of membership for which he is qualified. Those who are stimulating transfers work should not be disturbed from the viewpoint of professional ethics. He emphasized the need to fill in the record of experience on applications completely so that the committee can see what the applicant has done. In cases of the Fellow grade, applications are studied by the entire membership of the Board of Examiners and then they are referred to the Board of Directors for approval. Names are posted in *Electrical Engineering;* for applicants from overseas about 90 days' time is required. The actions of the committee and the final verdict depends on the information in the application; hence a full statement of experience and accomplishment should appear on the form and not merely a chronological recital. Representatives present were urged to carry this message back to their respective Sections.

SECTION ORGANIZATION AND GROWTH

Chairman Hough said that in 1953 the Susquehanna Section and the New Hampshire Section were installed as the 99th and 100th AIEE Sections, respectively. Vice-President Morton outlined certain counties to be transferred from the Lehigh Valley Section to the Susquehanna Section, which were approved.

The plan to stimulate and measure Section growth awards by the increased membership and meeting attendance was outlined by V. L. Ingersoll. In the last $1^1/_2$ years, the plan has been brought up-to-date so that the awards at the Summer and Pacific General Meeting this year in Los Angeles will be on the basis of records over the current year, 1953–54. The closing date for all records to be in at Institute headquarters is May 1. Promptness in this respect is very important; last year some Sections did not submit their records in time to be considered.

PUBLICITY AND REPORTS

The chairman of the Committee on Public Relations, R. T. Ferris, outlined the work being done in an expanded field of public relations operations. He referred to booklets and brochures, one of which is designed to interest young students in electrical engineering, and to the assistance rendered to the local publicity committees for the Sections, General and District meetings, and technical conferences to help them convey to the public the work of the engineer. Radio scripts and new feature mats for the press-at-large are in preparation. In conclusion, Mr. Ferris urged that whenever a General or District meeting is in prospect, the local committee should contact the chairman of the Committee on Public Relations or Raymond C. Mayer so that they can be of assistance.

Attention was drawn to the need for Section delegates to make specific reports to their Sections after attending the Section Delegates' Conference at the Summer General Meeting.

Several of the Sections reported that the illustrated lecture, "This is Your Institute," prepared by Assistant Secretary Nelson S. Hibshman, which highlighted various Institute activities, had been given and was very favorably received. Effectively illustrated with lantern slides, the lecture gave to those attending the meetings an insight and picture of Institute operations which they never had seen or realized heretofore.

RECOGNITION

It was reported that the Board of Directors at the November 5, 1953, meeting decided not to allow credit toward the requirements for the grade of Associate Member for the engineer-in-training certificate. The chairman of the Committee on Student Branches advised that the whole matter of student memberships in nonaccredited schools was under study by a subcommittee.

On behalf of a specially appointed subcommittee, Bradley Cozzens presented the design of an award certificate for past Section chairman. That such a certificate be made available was believed desirable but that a similar certificate should be awarded to vice-presidents was not considered to be appropriate because the office is above the Section level. A motion was carried to the effect that a certificate with wording as indicated should be awarded to past Section chairmen and the Board of Directors subsequently approved the recommendation in principle.

A motion that the authorization for the District Student Prize Paper Competition should include travel funds for the District secretary and vice-president as well as the District chairman of the Committee on Student Branches was carried. This subsequently was approved by the Board of Directors.

REMARKS BY PRESIDENT ROBERTSON

The President emphasized that the Board of Directors has an honest desire to conduct the affairs of the Institute in a way which the majority of members desire. As suggestions will be the considered opinions of those making them, he assured that serious consideration would be given to such suggestions.

The President explained that a letter was going out which would help the next administration to obtain the best qualified members for committee appointments. The appointment of a small committee to study and make the right recommendations for appointments was suggested. Such a committee should make certain that those who are suggested will serve, as the incoming chairmen are anxious to obtain the best people possible.

In conclusion, Chairman Hough called for suggestions from the Sections on matters that should be discussed at the Section Delegates' Conference to be held during the 1954 Summer and Pacific General Meeting in Los Angeles.

Forum of Technical Committee Chairmen Considers AIEE Meetings, Author's Guide

At the Wednesday evening Forum of Technical Committee Chairmen, L. F. Hickernell, chairman of the AIEE Committee on Technical Operations, presented AIEE President Elgin B. Robertson, who reiterated his belief in the Forum saying he was certain good will come from its conclusions if good engineering sense is used, no matter what new faces appear on the Board of Directors.

Mr. Robertson asked the Forum to consider the limiting of the number of sessions and papers at the AIEE Winter Meeting, stating that he thought a ceiling should be established and that the committee chairmen should be a little bit selective in choosing papers.

As the Edison Medal and Lamme Medal Committees are always looking for talent for medalists, committee chairmen were urged to submit names to the medal committees after carefully screening the candidates. Mr. Robertson also spoke about the selection of committee members; chairmen should canvass their personnel and then submit names of future committee members and the reasons for their selections.

MEETING SCHEDULES

Mr. Hickernell discussed the meetings situation. It was intended originally that the Fall General Meeting was to relieve the Winter Meeting of the papers load, but this has not been achieved. It was suggested that more papers be scheduled for the next Fall Meeting in Chicago, Ill.

The locations of the Summer General Meetings were discussed, one of the main problems being the finding of a hotel of sufficient capacity. It was proposed that summer divisional meetings be substituted (that is, a meeting of the electronics, communication, and general industry groups) but, it was pointed out, all members then would not attend the Summer Meeting.

Mr. Hickernell then reviewed the procedure and philosophy of conference papers, saying that abstracts of these papers should be reviewed 75 days before a meeting by the committees. He asked how successful this

had been. After some discussion from the floor in which conference papers were defended, it was concluded there were no violent objections.

The subject of conference papers being re-presented for discussion at a subsequent meeting in order to give them "*Transactions* status" was next mentioned. Several members dislike this idea but no substitute was offered.

Mr. Hickernell asked for a discussion of the new forms for reviewers' opinions of papers. It was agreed that the revision was an improvement. This was followed by presentation of a table showing the membership, registration at meetings, number of different types of papers presented at meetings, registration per paper, and similar data.

CONFERENCE PAPERS

M. D. Hooven, chairman of the Publication Committee, outlined the plans for printing and distributing "conference" papers before meetings, in the same way that "technical" papers are now. This would mean that conference papers, with text and illustrations prepared according to the Institute's standard form as stated in the new "Author's Guide" pamphlet, must be at Headquarters ready for preprinting at least 60 days before the meeting date. Copies of late conference papers brought to the meetings by authors will be sold by the Institute at a price to be determined. This procedure is essential to prevent individuals from picking up several copies. As it is impossible to estimate the number of conference papers to be presented in the coming year, the cost of preprinting, selling, mailing, and storing them, has been estimated only approximately to be between $15,000 and $20,000.

Mr. Hickernell then asked the Forum members if they would endorse this plan and by a show of hands it was endorsed.

(*Editor's Note: This plan was approved on the following day by the Board of Directors.*)

REVISED AUTHOR'S GUIDE

Mr. Hickernell explained to the Forum the revised "Author's Guide" and recommended that technical committee chairmen bring it to the attention of all authors. C. S. Rich, AIEE editor, explained the section of the new "Author's Guide" on the preparation of drawings for lantern slides and for publication in the magazines.

Mr. Rich stated that, based on the minimum subtended angle of vision for 50 per cent of normal sight, larger lettering is needed. Slides were shown illustrating the need for larger lettering on lantern-slide copy. Projection at meetings is usually under very adverse conditions and so slides should be designed for a projection ratio of 9W, a viewing distance of nine times the screen image width in order to be seen in the back rows. This results in lettering larger than should be used on copy for publication which is prepared for a 3-to-1 reduction, as explained in the new "Author's Guide."

AIEE Board of Directors Holds January Meeting in New York City

The regular meeting of the AIEE Board of Directors was held at Institute headquarters, New York, N. Y., on January 21, 1954.

The minutes of the meeting of the Board of Directors held on November 5, 1953, were approved as previously distributed.

EXECUTIVE COMMITTEE

Actions of the Executive Committee on membership applications as of November 27, and December 28, 1953, were reported and confirmed, as follows: 141 applicants transferred, 11 elected, and 2 re-elected to the grade of Member; 334 applicants elected and 30 re-elected to the grade of Associate Member; 71 applicants elected to the grade of Affiliate; 1,931 Student members enrolled.

BOARD OF EXAMINERS

Recommendations adopted by the Board of Examiners at meetings held on November 19 and December 17, 1953, and January 14, 1954, were reported and approved, including the following: 34 applicants transferred, 4 elected, and 1 re-elected to the grade of Member; 172 applicants elected, 1 reinstated, and 13 re-elected to the grade of Associate Member; 37 applicants elected to the grade of Affiliate; 106 Student members enrolled.

The Board of Examiners submitted seven proposals for transfer to the grade of Fellow with a favorable recommendation and a recommended citation in each case. The Board of Directors voted to invite the seven Members to be transferred to the grade of Fellow, as follows:

P. C. Goldmark, vice-president in charge of engineering, research and development department, Columbia Broadcasting System, 485 Madison Avenue, New York 22, N. Y.

Harold L. Durgin, executive vice-president and director, Central Vermont Public Service Corporation, 121 West Street, Rutland, Vt.

John K. Ostrander, consulting electrical engineer, United Engineers and Constructors, Inc., 1401 Arch Street, Philadelphia 5, Pa.

L. H. Hardin, superintendent outside lines, Savannah River Project, The Du Pont Company, Post Office Box 117, Augusta, Ga.

Nathan Cohn, manager, West Central Region, Leeds and Northrup Company, 307 North Michigan Avenue, Chicago 1, Ill.

E. B. Paxton, supervisor, electrical and related standard services department, General Electric Company, Schenectady, N. Y.

A. F. Briggs, section head of electrical department, Post Office Drawer 2831, Beaumont, Tex.

More information regarding the aforementioned individuals will appear in a forthcoming issue of *Electrical Engineering* in the department "AIEE Fellows Elected."

FINANCES

Treasurer Walter J. Barrett, who was unable to attend the meeting, submitted a written report for the first 8 months of the fiscal year, which ends April 30, 1954, and the Board voted to accept this report.

Chairman Purnell of the Finance Committee reported disbursements from general funds as follows: November 1953—$111,283.05; December 1953—$82,301.01; January 1954—$96,396.21. The report was approved.

Copies of a comparative statement of income and expenses during the expired portion of the present budget year were distributed. It showed that the income to January 15, 1954, was $228,900, or about 19 per cent of the estimated income for the appropriation year, ending September 30, compared with about 19 per cent last year. Expenses for the 4 months ended January 31, 1954, were $420,300, or about 33 per cent of the estimated expenses for the appropriation year, compared with about 33 per cent last year.

The Board adopted a resolution to drop from membership any member owing dues for the fiscal year ending April 30, 1953, with the understanding that the suspended member may become reinstated without the formality of an application if outstanding dues are paid prior to May 1, 1954.

The Board also adopted a resolution that the Secretary be authorized to accept during the fiscal year beginning May 1, 1954, payment of membership dues on the basis of the par currency value of the countries affected by abnormal exchange rates—the member concerned to be granted an exchange allowance corresponding to the difference between the New York exchange value and the normal par of his currency, such allowance not to exceed 40 per cent of the dues payable and not to apply to purchases of, or subscriptions to, Institute publications; a corresponding reduction in appropriation payments to be applicable to Institute Sections in any countries affected.

The Secretary reported that as of December 31, 1953, the membership of the Institute, not including Students, was 47,710.

The Board voted to amend the budget, adding an additional appropriation of $2,580.00 to cover the AIEE assessment by Engineers Joint Council (EJC) for the first three quarters of the calendar year 1954.

The Finance Committee approved the lease of an additional room on the Lower Level at 500 Fifth Avenue adjacent to the quarters of the editorial department for a period from December 1953 to April 1955. The Board approved the recommendation that an additional appropriation be provided for in the budget.

The Board approved the recommendation that the travel allowance be continued for the Vice-President of District 10 to visit the Vancouver Section.

RECOMMENDATIONS AND REPORTS

Chairman D. A. Quarles of the Advisory Committee on Honors resigned the chairmanship of this committee, due to the pressure of the duties of his present office. The Board voted to accept his resignation and to authorize the President to appoint a new chairman of the committee.

Upon recommendation of the Committee

Ridgway Section Scholarship Winner

C. F. McGinnis, chairman of the AIEE Ridgway Section's Vocational Guidance Committee which sponsored the first Elk County Engineering Scholarship, is shown shaking hands with William Gallagher (right), the award winner, upon payment of the second portion of the annual award money. Mr. Gallagher is attending the State University of Pennsylvania. Other members of the committee looking on are (left to right): M. S. May, R. F. Edwards, W. H. Austry, J. H. Schneider, and Quentin Graham

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on Constitution and Bylaws, the Board approved the addition of the following paragraph to Section 12 and the amendment of Section 67b of the Bylaws:

Section 12. A member of The American Society of Mechanical Engineers who applies for a corresponding grade of membership in the American Institute of Electrical Engineers shall not be required to pay any initiation or entrance fee. Such an applicant must file a formal application for membership and must meet the membership requirements for the grade of membership for which he applies. This exemption shall apply only for entrance to an equivalent or a lower grade of membership.

If such an application is for entrance to a higher grade of membership, the applicant shall pay to the American Institute of Electrical Engineers the transfer or promotion fee as required by the Bylaws for such a transfer.

Section 67b. First sentence amended to read as follows:

The Advisory Committee on Honors shall consist of six members of Fellow or Member grade, appointed by the Board of Directors; six to be appointed initially with two each for 1-year, 2-year, and 3-year terms, and thereafter two to be appointed each year for a term of 3 years, all terms being from August 1st of the year in which they are appointed.

Upon recommendation of the Committee on Planning and Co-ordination, the Board approved the organization of a subcommittee of the Committee on Planning and Co-ordination to study the question of Special Technical Conferences and co-ordinate the recommendations of the Committee on Technical Operations, Publication Committee, and Finance Committee, the personnel of the committee to be: C. S. Purnell, chairman; L. F. Hickernell, and M. D. Hooven.

The Committee on Planning and Co-ordination recommended that the AIEE undertake to canvass its members in the United States by questionnaire on the matter of "Employment Conditions," so as to provide data to be added to those already collected by the American Society of Civil Engineers (ASCE) and The American Society of Mechanical Engineers (ASME) for the purpose of contributing to the legislative discussion of possible amendments of the Taft-Hartley Law, and that the questions be designed to elicit the same information as those used by ASCE and ASME, but that they not be limited to this information if, in the opinion of the Drafting Committee, additional information of interest to the Institute can be secured without endangering the basic data needed by EJC. It was also recommended that the drafting of the final questionnaire be referred to F. K. McCune, chairman of the Drafting Committee, with instructions to consider the suggestions received from members of the Committee on Planning and Co-ordination and other sources, and with the expectation that the final draft will be tried on a representative group of members before it is issued, that final approval of the questionnaire be delegated to the Executive Committee of the Board of Directors, and that the necessary funds be appropriated to carry out the recommendation. The recommendations of the Committee on Planning and Co-ordination were approved by the Board.

It was recommended by the Committee on Planning and Co-ordination that its Subcommittee on Redistricting, which was organized to study various plans for redistricting the Institute for the purpose of relieving excessively heavy visitation schedules by the Vice-Presidents, be discharged, with expressions of appreciation for its great effort.

It was further recommended that a committee consisting of the Vice-Presidents of Districts 1, 2, 4, 5, and 7 be appointed a subcommittee of the Board of Directors to propose a solution of the problem of heavy visitation schedules. The Board voted to approve the recommendation, and the President was authorized to appoint the chairman of the subcommittee of five Vice-Presidents.

Upon recommendation of the Committee on Planning and Co-ordination, the Board authorized the following meetings:

District 4 Meeting, St. Petersburg, Fla., April 13–15, 1955

District 2 Meeting, Columbus, Ohio, week of May 1, 1955

District 1 Meeting, Rochester, N. Y., May 2–4, 1956

It was recommended that a District 1 Meeting to be held in Pittsfield, Mass., in April or May, 1957, be tentatively approved. The recommendation was approved.

It was voted that the 1954 Annual Meeting be held in Los Angeles, Calif., on Monday, June 21, 1954, as a part of the 1954 Summer and Pacific General Meeting, and that the dates of the 1956 Winter General Meeting be confirmed for New York City, at the Hotel Statler, January 30–February 3, 1956.

Upon recommendation of the Sections Committee, the Board approved the transfer of the following counties in Pennsylvania, which were in the territory of the Lehigh Valley Section, to the territory of the Susquehanna Section: Dauphin, Cumberland, Perry, Juniata, Lebanon, and Mifflin.

It was recommended that a certificate for past Section chairmen be prepared at Institute headquarters, signed by the Institute Secretary, transmitted to the District Vice-President for his signature, and passed to Sections for the signature by the incoming chairman of the Section when presentation is desired by the Section. This was approved.

A resolution prepared by the Schenectady Section with regard to a "Unity Organization," was read.

The Board approved the recommendation that travel funds be provided for the District Branch Paper Prize Contest so that the Vice-President, the District secretary, and the chairman of the District Committee on Student Activities may receive travel allowances for attending these contests.

Chairman L. F. Hickernell of the Committee on Technical Operations gave a report on the activities of his committee, including a desire of the Petroleum Industry Subcommittee for full committee status in the Industry Division rather than, as at present, that of a subcommittee of the Committee on Chemical, Electrochemical, and Electrothermal Applications. The creation of the Petroleum Industry Committee as a committee in the Industry Division was approved by the Board.

It was reported that at the January meeting of the board of directors of the Institute of Radio Engineers (IRE), it was voted, subject to similar action by the AIEE Board of Directors, to abolish the Joint AIEE–IRE Co-ordination Committee and the Joint AIEE-IRE Student Branch Co-ordinating Subcommittee, and to establish an *ad hoc* committee, this committee to consist of two members representing IRE and two members representing AIEE, and to have responsibility for working out an improved plan of Joint Student Branch operation. Dean W. L. Everitt of the University of Illinois and Professor Ferdinand Hamburger, Jr., of Johns Hopkins University were appointed by the IRE as its two representatives on this committee. Similar action was recommended, and the Board voted to take the same action with respect to the Joint Co-ordination Committee and the Joint Student Branch Subcommittee as that taken by the Executive Committee of IRE, and to empower the President to appoint two members of AIEE to the proposed *ad hoc* committee.

Chairman R. F. Danner of the Com-

mittee on Student Branche sgave a report on the activities of his committee.

The Board voted to approve the "Transfers Guide" as submitted by the Committee on Transfers, for distribution to all Sections and other parties interested in transfers activities.

It was voted to approve, in principle, the recommendation of the Publication Committee, which was endorsed by the Committee on Technical Operations, that the Institute undertake to make available duplicated copies of all conference papers scheduled for General or District meetings, or Special Technical Conferences, which meet the standards and dead-line specified by the Publication Committee and the Committee on Technical Operations, and to instruct the Publication Committee and the Committee on Technical Operations to proceed with the establishment of policies, procedures, and facilities for the production, announcement, sale, and distribution of conference papers.

The Board authorized the President, with the help and advice of Past President Quarles, to appoint six representatives of AIEE to the Advisory Committees of the Bureau of Standards, as requested.

ATTENDANCE

Present at the meeting were: *President* Elgin B. Robertson; *Past Presidents* F. O. McMillan and D. A. Quarles; *Vice-Presidents* C. P. Almon, Jr., A. S. Anderson, W. L. Cassell, G. D. Floyd, W. Scott Hill, M. D. Hooven, C. M. Lytle, Walter B. Morton, and G. C. Tenney; *Directors* F. R. Benedict, D. I. Cone, R. F. Danner, D. D. Ewing, L. F. Hickernell, T. M. Linville, A. C. Muir, N. C. Pearcy, C. S. Purnell, E. W. Seeger, Victor Siegfried, J. C. Strasbourger; *Secretary* H. H. Henline; and *Assistant Secretary* N. S. Hibshman.

American Power Conference Program Will Include AIEE-Sponsored Sessions

The American Power Conference, successor to the Midwest Power Conference, will be held March 24–26, 1954, at the Sherman Hotel in Chicago, Ill.

The purpose of the conference is to provide a national forum for discussion of problems and for the exchange of information concerning matters of interest to the power industry and associated lines of endeavor. The program is planned with emphasis on the broad over-all aspects of the subject rather than the intricate technical details. Papers will emphasize the practical rather than the theoretical point of view. The conference is sponsored by the Illinois Institute of Technology in co-operation with nine universities and four regional associated universities as well as nine local and national engineering societies including AIEE.

LIGHT'S DIAMOND JUBILEE

In commemoration of the 75th anniversary of the invention of the electric light by Thomas A. Edison, the conference is arranging a special Diamond Jubilee Dinner and other appropriate events.

NATIONAL POWER SHOW

The 52d National Power Show, sponsored by the National Association of Power Engineers, will run concurrently in the Sherman Hotel. Everyone attending the conference is cordially invited to attend this show. Exhibits of interest to the power industry will be on display.

REGISTRATION

A registration fee of $8.00 will be charged, which will entitle the registrant to a cloth-bound volume of the proceedings when available. Additional copies of the proceedings may be ordered at the Registration Desk or by mail at the price of $6.00 per copy. All persons interested in the conference are invited to attend and register in advance by mail on or before Friday, March 19, with E. R. Whitehead, Secretary, American Power Conference, Illinois Institute of Technology, Technology Center, Chicago 16, Ill. The registration badge, picked up at the Registration Desk on arrival, will serve as a ticket of admission to all sessions of the conference.

Preliminary Program

American Power Conference, March 24-26

Wednesday, March 24

9:00 a.m. Registration, Sherman Hotel

10:00 a.m. Opening Meeting

Presiding: Fischer Black, editor, *Electrical World*

Invocation. The Reverend Kenneth Hildebrand, The Central Church of Chicago

Opening Remarks. Lenox R. Lohr, president, Museum of Science and Industry, and general chairman, Light's Diamond Jubilee Celebration of American Power Conference

Research and the Electric Power Industry. J. E. Hobson, Stanford Research Institute; William A. Lewis, Illinois Institute of Technology

Address. Vice Admiral Harold G. Bowen, executive director, Thomas A. Edison Foundation

12:15 p.m. American Power Conference Luncheon

Sponsored by American Society of Mechanical Engineers

Chairman: Lewis K. Sillcox, president, American Society of Mechanical Engineers (ASME)

Vice-Chairman: M. F. Obert, chairman, Chicago Section, ASME

Speaker: Walter H. Sammis, president, Ohio Edison Company, and president, Edison Electric Institute—"The Power Industry—A Challenge to Engineers"

2:00 p.m. Central Station Steam Generation

Chairman: H. L. Solberg, Purdue University

Vice-Chairman: N. L. Markezich, co-chairman, Power and Fuels Division, Chicago Section, ASME

Performance of New Controlled Circulation Boilers. *E. M. Powell*, Combustion Engineering, Inc.

Cyclone-Furnace-Fired Boilers. *G. W. Kessler*, The Babcock and Wilcox Company

Pulsation-Induced Vibration in Utility Steam Generation Units. *R. C. Baird*, The Fluor Corporation, Ltd.

The Present and Future Status of the Fly Ash Disposal Problem. *C. M. Weinheimer*, The Detroit Edison Company

2:00 p.m. Hydroelectric Power Development in the United States

Chairman: F. W. Edwards, Stanley Engineering Company

Vice-Chairman: E. Montford Fucik, Harza Engineering Company, and president, Illinois Section, American Society of Civil Engineers (ASCE)

The Role of the Corps of Engineers in the Development of Water Resources. *Brigadier General E. C. Itschner, C. H. Giroux, G. A. Hathaway, Colonel G. J. Zimmerman*, Office of the Chief of Engineers, Gravelly Point, Va.

The Federal Multiple-Purpose Project—Its Role in the West. *H. B. Taliaferro, W. L. Newmeyer*, Bureau of Reclamation, United States Department of the Interior, Washington, D. C.

2:00 p.m. Industrial Plant Session

Sponsored by the National Association of Power Engineers

Chairman: Gerald Mierendorf, president, National Association of Power Engineers

Vice-Chairman: Leslie F. Clifford, managing editor, *National Engineer*

Scale Modeling—A Practical Engineering and Construction Tool. *J. A. Carroll*, The Proctor and Gamble Company

Selection, Maintenance, and Piping Practice in Industrial Plants. *R. J. Pinske*, Crane Company

Planning and Installing an Electrical System in a Rapidly Growing Industrial Plant. *Hans Edergger, Jr.*, L. L. Weldy and Associates; *M. W. Stehr*, Wisconsin Electric Power Company

2:00 p.m. Station Apparatus

Sponsored by Power Group, AIEE Chicago Section

Chairman: J. A. M. Lyon, chairman, Power Group, AIEE Chicago Section

Vice-Chairman: H. A. Peterson, University of Wisconsin

Continuity of Service at Distribution Voltages by Means of Ring Bus. *Derio Dalasta*, Allis-Chalmers Manufacturing Company

Reduction of Transformer Sound. *T. R. Specht, L. R. Rademacher*, Westinghouse Electric Corporation

3:30 p.m. Industrial Electrical Session

Sponsored by Industrial Group, AIEE Chicago Section

Chairman: W. O. Schnell, chairman, Industrial Group, AIEE Chicago Section

Vice-Chairman: F. W. McCloska, Sargent and Lundy, Engineers

Recent Developments in Pipe-Line Electrification. *Merritt Hyde*, Westinghouse Electric Corporation

Open Hearth Versus Electric Furnace Economics and Their Significance to the Power Industry. *D. D. Moore*, Battelle Memorial Institute

6:45 p.m. Light's Diamond Jubilee Dinner

Presiding: Lenox R. Lohr

The Varsity Glee Club of Purdue University, Albert P. Stewart, director

Message from the President of the United States

Speaker: Colter Hamilton Moses, chairman, Arkansas Power and Light Company

Thursday, March 25

9:00 a.m. Central Station Steam Turbines

Chairman: Raymond D. Maxson, Commonwealth Edison Company

Vice-Chairman: Elmer C. Lundquist, State University of Iowa

Steam Turbine Development. *C. C. Franck*, Westinghouse Electric Corporation

Trends in Design of Present-Day Steam Turbines. *C. D. Wilson, E. P. Hansen*, Allis-Chalmers Manufacturing Company

The Steam Turbine of Tomorrow. *R. S. Neblett*, General Electric Company

9:00 a.m. Fuel Economics

Chairman: Milton Fies, Alabama Power Company

Vice-Chairman: M. A. Elliott, Illinois Institute of Technology

Economic Trends in Natural Gas. *R. J. Gonzales*, Humble Oil and Refining Company

Future of Coal in Power Generation. *G. A. Lamb*, Pittsburgh Consolidation Coal Company

Nuclear Fuels for Power Generation. *W. F. Friend*, Ebasco Services, Inc.

9:00 a.m. Year-Round Air Conditioning

Chairman: W. T. Reace, Commonwealth Edison Company

Vice-Chairman: S. P. Kezios, Illinois Institute of Technology

Factors Affecting the Installation of Year-Round Air Conditioning in Homes. *L. H. Hirschbach*, General Electric Company

Climatic and Geographic Evaluation of Potential Comfort Air-Conditioning Loads. *J. R. Hertzler, V. T. Kartorie*, York Corporation

10:30 a.m. Water Technology Number 1

Sponsored by Joint Research Committee on Boiler Feedwater Studies

Chairman: R. C. Adams, chairman, Joint Research Committee on Boiler Feedwater Studies, U. S. Naval Engineering Experiment Station

Vice-Chairman: Selden Adkins, National Aluminate Corporation

Evaluation of Several Alkaline Compounds for Controlling Corrosion in Boiler Feedwater Systems. *J. M. Decker, J. C. Marsh*, The Detroit Edison Company

High-Temperature Water for Process Heating Combined With Power Production. *P. L. Geiringer, Floyd Hasselriis*, American Hydrotherm Corporation

10:30 a.m. Distribution Systems

Chairman: J. N. Banky, Allis-Chalmers Manufacturing Company

Vice-Chairman: G. G. Freyder, Utilities Research Commission

Electric Distribution for Future Loads. *W. R. Bullard, Chase Hutchinson, R. E. Pierce*, Ebasco Services, Inc.

Limitations Imposed on Distribution System By Utilization Voltage. *L. G. Smith*, Consolidated Gas Electric Light and Power Company

12:15 p.m. American Power Conference Luncheon

Sponsored by AIEE

Chairman: Elgin B. Robertson, president, AIEE

Vice-Chairman: R. W. Jones, chairman, AIEE Chicago Section

Speaker: Jerome K. Kuykendall, chairman, Federal Power Commission

2:00 p.m. Central Station Steam Power Plants

Chairman: Ben G. Elliott, University of Wisconsin

Vice-Chairman: W. A. Pollock, Wisconsin Electric Power Company

Supercritical Pressure Steam Power Cycles. *Jerome Bartels*, Polytechnic Institute of Brooklyn, and associated with Gibbs and Hill, Inc.

The Gallatin Steam Plant of the Tennessee Valley Authority. *C. E. Blee, H. J. Petersen*, Tennessee Valley Authority

The Economy of Large Generating Units. *H. P. Seelye, W. W. Brown*, The Detroit Edison Company

2:00 p.m. Water Technology Number 2, Symposium on Demineralization

Chairman: J. F. Wilkes, Dearborn Chemical Company

Vice-Chairman: W. R. Homan, Commonwealth Edison Company

Demineralized Water for 1,500-Psi Steam Plant—Design Aspects. *C. R. Stewart*, Stone and Webster Engineering Corporation

Demineralized Water for 1,500-Psi Steam Plant—Operating Aspects. *W. B. Gurney*, Gulf States Utilities

Automatic Mixed Bed Demineralizing at the Niagara Mohawk Power Company. *Durando Miller*, The Permutit Company; *T. J. Finnegan*, Niagara Mohawk Power Company

The Expected Life of Anion Exchangers Under Various Conditions of Deionizer Design and Operation. *Louis Wirth*, National Aluminate Corporation

2:00 p.m. Industrial Power Plants—Economic Aspects

Chairman: L. C. Price, Michigan State College

Vice-Chairman: F. B. Banton, Consulting Engineer in Power Plants

Economic Factors Affecting Selection and Replacement of Power Plant Equipment. *G. J. Matchett*, Illinois Institute of Technology

Hawthorne Power Plant Rehabilitation Economics. *C. E. Morrow, R. F. Born*, Western Electric Company

2:00 p.m. Electrical Systems

Chairman: G. Ross Henninger, Iowa State College

Vice-Chairman: Evrett B. Eggers, Illinois Institute of Technology

Load Structure of a Modern Electrical Utility System. *C. W. Bary*, Philadelphia Electric Company

Service Continuity Standards Aid Planning and Operation. *W. J. Lyman, V. E. Hill*, Duquesne Light Company

3:30 p.m. Cables for Transmission and Distribution

Chairman: J. G. Tarboux, University of Michigan

Vice-Chairman: E. A. Cooper, Harza Engineering Company

Aerial Cable for Distribution Systems. *H. M Bankus, F. C. Van Wormer*, General Electric Company

Aluminum for Underground Cable Sheaths. *K. S. Wyatt*, Phelps Dodge Copper Products Corporation

6:45 p.m. All Engineers Dinner

Presiding: Dr. J. Roscoe Miller, Northwestern University

Speaker: The Honorable Douglas McKay, Secretary of the Interior, Washington, D. C.

Friday, March 26

9:00 a.m. Nuclear Energy

Chairman: Alfonso Tammaro, Atomic Energy Commission

Vice-Chairman: Newman A. Hall, University of Minnesota

Economic Aspects of Various Types of Nuclear Reactors. *D. H. Loughridge*, Northwestern Technological Institute

Technology of the Use of High-Pressure Water for Reactors. *A. Amorosi*, Argonne National Laboratory

Problems of Operation of Nuclear Power Plants. *R. L. Doan*, Phillips Petroleum Company

9:00 a.m. Water Technology Number 3

Chairman: Claire Fellows, representative, Power Station Chemistry Subcommittee, Prime Movers Committee, Edison Electric Institute

Vice-Chairman: M. F. Obrecht, Department of Chemical Engineering and Water Treatment Consultant to Michigan State College

Water Problems in the Nuclear Power Field. *R. C. Ulmer*, Combustion Engineering, Inc.

Boilers and Boiler Waters—Interlocking Advances in Design. *H. M. Rivers, S. R. Osborne*, Hall Laboratories

9:00 a.m. Steam and Diesel Power Plants

Chairman: W. P. Green, Armour Research Foundation

Vice-Chairman: Max E. Ephraim, General Motors Corporation

Toward a More Successful Operation of Diesel Generating Facilities. *R. J. Daverman, J. A. DeWinter, J. H. Knol*, J and G Daverman Company

Steam and/or Diesel? *S. K. Fosholt*, Stanley Engineering Company

9:00 a.m. Electronics

Sponsored by Electronics Group, AIEE Chicago Section

Chairman: J. H. Enenbach, chairman, Electronics Group, AIEE Chicago Section

Vice-Chairman: Paul Glass, Askania Regulator Company

Operating Experience With Microwaves in a Power System. *E. A. Shultz, H. G. Goers*, Illinois Power Company

10:30 a.m. Water Technology Number 4

Chairman: S. F. Whirl, Duquesne Light Company

Vice-Chairman: T. J. Hodan, Allis-Chalmers Manufacturing Company

Silica Removal by Salt Splitting Without Demineralizing. *S. B. Applebaum*, Cochrane Corporation; *B. W. Dickerson*, Hercules Powder Company

Some Chemical Aspects of Hot Process–Hot Zeolite Plant Performance. *M. Lane, J. H. Duff*, Graver Water Conditioning Company

10:30 a.m. Gas Turbines for Power Generation

Chairman: B. H. Jennings, Northwestern University

Vice-Chairman: J. S. Yampolsky, Ford Motor Company

Gas Turbines for the Power Industry. *T. J. Putz*, Westinghouse Electric Corporation

A New Power Cycle Combines Gas Turbine With Steam Turbines. *L. S. Gee*, West Texas Utilities Company

10:30 a.m. Circuit Breakers

Chairman: William A. Lewis, Illinois Institute of Technology

Vice-Chairman: Lester B. LeVesconte, Sargent and Lundy, Engineers

High-Voltage Air-Blast Breakers for High Interrupting Capacity. *Hans Meyer*, Brown, Boveri and Company, Baden, Switzerland; *W. R. Streuli*, Brown, Boveri Corporation, New York

Modern Low-Oil-Content High-Voltage Circuit Breakers. *B. C. West, Paul Wildi*, Pacific Oerlikon Company

12:15 p.m. American Power Conference Luncheon

Sponsored by the Western Society of Engineers

Chairman: Louis C. McCabe, Bureau of Mines, U. S. Department of the Interior

Vice-Chairman: John F. Sullivan, Jr., vice-president, Western Society of Engineers

Speaker: Thomas E. Murray, member, Atomic Energy Commission

2:00 p.m. Gas Turbines and Diesel Engines—Performance and Applications

Chairman: J. I. Yellott, Bituminous Coal Research, Inc.

Vice-Chairman: D. G. Ryan, University of Illinois

Performance of 2,400-Hp "Trainmaster" Diesel Locomotives. *Robert Aldag*, Fairbanks, Morse and Company

Use of Gas Turbine-Electric Locomotives on the Union Pacific Railroad Company. *F. Fahland*, Union Pacific Railroad Company

Factors Associated With Use of Gas Turbines for Automotive Applications. *J. H. Bonin, R. A. Harmon*, Armour Research Foundation

Gas Turbines in the Steel Industry. *G. H. Krapf*, United States Steel Corporation

2:00 p.m. Industrial Steam Generation

Chairman: M. B. Golber, Armour and Company

Vice-Chairman: W. F. Bohmke, chairman, Power and Fuels Division, ASME Chicago Section

Some Economic Factors Influencing Industrial Boiler Manufacture. *C. E. Miller*, Combustion Engineering, Inc.

Operating Experiences With a MultiFuel Stoker-Fired Boiler. *G. G. Bachman*, Omaha Public Power District

Industrial Operating Experience With Cyclone-Fired Boilers. *L. L. Moran*, The Dow Chemical Company

2:00 p.m. Symposium on Network Analyzers and Computing Aids

Chairman: Eric T. B. Gross, Illinois Institute of Technology

Vice-Chairman: Ralph D. Goodrich, Bureau of Reclamation

Group A—Network Analyzers

The Co-ordinated Use of A-C and D-C Network Analyzers. *J. A. Casazza, W. S. Ku*, Public Service Electric and Gas Company

Network Analyzer Operational Problems and Methods. *M. E. Gillihan*, Department of Water and Power, Los Angeles

Group B—Digital Computers

Applications of Digital Analysis to Power System Problems. *G. W. Bills*, Bonneville Power Administration

Progress in the Application of Digital Computers to Power Systems Problems. *F. J. Maginniss*, General Electric Company

Digital Computers in Power System Engineering. *W. D. Trudgen*, The Detroit Edison Company

2:00 p.m. Electric Circuit Breakers

Chairman: D. D. Ewing, Purdue University

Vice-Chairman: Noah Pearcy, Pioneer Service and Engineering Company

Recent Developments in Power Circuit Breakers. *A. W. Hill*, Westinghouse Electric Corporation

Trends in Design and Application of Tank-Type Power Circuit Breakers. *L. J. Linde, A. E. Kilgour*, Allis-Chalmers Manufacturing Company

Switchgear Equipment for Super-Voltage Transmission. *R. M. Bennett*, General Electric Company

Fourth Scintillation Counter Symposium Is Held in Washington With 400 Attending

The fourth Scintillation Counter Symposium at the Shoreham Hotel, Washington, D. C., was held on January 26–27, 1954, and the attendance of nearly 400 engineers and scientists came from all parts of the country. In addition to the AIEE, the sponsors were the Institute of Radio Engineers, Atomic Energy Commission, and the National Bureau of Standards (NBS). Included in the program were 9 invited papers and 17 were contributed, covering in general the following topics: scintillation counter spectrometry; photomultipliers and phosphors; general applications; and cosmic-ray and high-energy particle measurements with scintillation counters. In addition to the four daytime sessions, an evening conference and round-table discussion on photomultipliers and scintillators was conducted with G. A. Morton, RCA Laboratories, as moderator.

Dr. R. D. Huntoon, Associate Director for Physics, NBS, welcomed the visitors and extended a cordial invitation to visit the many projects in which they might be interested. Then W. H. Jordan, Oak Ridge National Laboratory, the chairman of the opening session, outlined the subjects to be covered in the several sessions.

P. R. Bell, Oak Ridge National Laboratory, described the performance of large sodium-iodide crystals, one being 3 inches high and 3 inches in diameter and another $4^3/_4$ inches in diameter. The pulse light distribution given by such crystals was shown and the optimum shape of a spectrometer crystal discussed.

Another spectrometer using a 5-inch-diameter sodium-iodide crystal 8 inches long was described by H. W. Koch, NBS. This total-absorption instrument was built to measure the energy of individual X-ray photons in the range between 1/2 and 50 million electron volts with an energy resolution of better than 11 per cent and a detection efficiency greater than 80 per cent. The sodium-iodide crystal of this size almost totally absorbs the X-ray photons, the absorption resulting in a light pulse. With the proper design, the magnitude of this pulse provides the X-ray photon energy.

Four contributed papers followed, the subjects covered being a double-line linear amplifier, a 60-channel electron-beam pulse-amplitude analyzer, a twin-scintillation method for studying neutrons in the presence of gamma rays, and the response of LiI(Eu) to fast electrons.

PHOTOMULTIPLIERS AND PHOSPHORS

The afternoon session, devoted to photomultipliers and phosphors, was presided over by J. B. H. Kuper, Brookhaven National Laboratories. New photomultipliers of two manufacturers were described by R. W. Engstrom, Radio Corporation of America, and B. R. Linden of the Allen B. DuMont Laboratories. In these papers recent developments of multiplier phototubes and a preview of tubes now in the laboratory stage were presented.

R. K. Swank, Argonne National Laboratory, in his paper on "Scintillation Phosphors" discussed the scintillation process relative to the commonly used phosphors such as organic crystals, liquids, and plastics, as well as tungstates and alkali halides. A summary was given of the luminescent properties of important scintillators as well as the problems in the measurements of these properties.

SCINTILLATION COUNTERS

George Cowper, Atomic Energy of Canada, Ltd., opened the second day's sessions (D. L. Collins, Victoreen Instrument Company, chairman) with "Aerial Prospecting With Scintillation Counters." Early work in this form of prospecting was done with ionization chambers and Geiger counters, but with modern scintillation counters flown in a helicopter at an altitude of 500 feet at 200 feet per second, uranium deposits have been located with remarkable exactness. The design of the instrument with which the tests were accomplished was described and examples of the charts showing the terrain's contours and the co-ordinated counter readings were exhibited.

This session being devoted to general applications of scintillation counters, papers were presented on a beta-ray microscope, d-c ratemeter techniques, counting natural radio carbon, and scintillators' use in medical radioisotope laboratories.

The final session of the conference, over which L. F. Wouters, University of California Radiation Laboratory, presided, was concerned with cosmic-ray and high-energy particle counting. Robert Hofstadter, Stanford University, presented "Application of Scintillation Counters to High-Energy Particle Counting," in which methods were described of measuring the energies of high-energy electrons and quanta by means of large-volume scintillators. From shower data of carbon, aluminum, copper, etc., an estimate can be made of the size of counter needed to obtain narrow pulse-height distributions in useful scintillation materials. Thus it is possible to make a spectrometer for high-energy electrons and quanta similar to those used at lower energies.

"Large-Volume Liquid Scintillators and Their Applications," was presented by F. B. Harrison, C. L. Cowan, and F. Reines, all of Los Alamos Scientific Laboratory. The 300-liter liquid scintillator for capturing free neutrinos was described. It was stated that the present system is limited by electronics to 3×10^{-7} second but the counter itself should measure in the region of 10^{-8} second.

The remainder of the papers dealt with liquid scintillation counters and their functioning; the response of sodium-iodide scintillators to high-energy mesons, and a counter with millimicrosecond resolution.

PROCEEDINGS

The proceedings of the Scintillation Counter Symposium consisting of the "invited" papers can be obtained for $1.00 and a report of all papers and discussions summarized can be obtained for 25 cents by ordering from *Nucleonics*, 330 West 42d Street, New York 36, N. Y. The chairman

of the Symposium Committee was G. A. Morton; secretary, R. W. Johnston; publicity and attendance, H. O. Wyckoff; program, R. K. Swank; and local arrangements, L. Costrell.

Technical Program Announced for Southern Textile Conference

A 2-day Conference on the Textile Industry will be held at Georgia Institute of Technology, Atlanta, Ga., April 15–16, 1954. It will be sponsored by the AIEE Subcommittee on Textile Industry of the General Industry Applications Committee. Three sessions have been scheduled for this conference which include the presentation of approximately seven papers. The tentative program is as follows:

Thursday, April 15, 1954

9:00 a.m. Registration
Auditorium, High Tower Textile Building

Morning Session

Swaffield Cowan, presiding, Factory Insurance Association, Charlotte, N. C.

10 a.m. Welcome. Blake R. Van Leer, president, Georgia Institute of Technology

10:15 a.m. Circuit Breakers as Applied to Textile Mills. *W. M. Emmons*, switchgear engineer, Westinghouse Electric Corporation, Atlanta, Ga.

11:00 a.m. High Interrupting Capacity Fuses. *J. C. Lebens*, chief engineer, Busman Manufacturing Company, New York, N. Y.

11:45 a.m. Discussion

12:30 p.m. Luncheon

Toastmaster—E. S. Lammers, Westinghouse Electric Corporation, Atlanta, Ga.

Afternoon Session

H. S. Colbath, presiding, plant engineer, Bibb Manufacturing Company, Macon, Ga.

2:30 p.m. Multimotored Slasher Drive for Magnetic Amplifier Tension Control. *A. T. Bacheler*, *J. G. Stephenson*, Westinghouse Electric Corporation

3:15 p.m. Slasher Instrumentation. *J. E. MacConville*, regional industrial manager, Minneapolis-Honeywell Regulator Company, Atlanta, Ga.

4:00 p.m. New Developments in Electric Equipment of Value to Textile Mills. *Ralph C. Lathem*, Georgia Institute of Technology, Atlanta, Ga.

4:45 p.m. Open Discussion

Friday, April 16, 1954

Morning Session

J. D. McConnell, presiding, plant engineer, Cone Mills, Greensboro, N. C.

9:30 a.m. NEMA Motor Re-rating Program by General Electric Company. Speaker—to be announced later

10:00 a.m. Electrical Modernization in a Textile Mill. *Walter L. Roark*, electrical engineer, Avondale Mills, Sylacauga, Ala.

10:30 a.m. (Title later.) *K. A. Richardson*, chief electrician, Bibb Manufacturing Company, Macon, Ga.

11:00 a.m. Panel Discussion on Mill Electrical Problems. Moderator, *J. D. McConnell*, Cone Mills; Panel, *J. E. MacConville*, Minneapolis-Honeywell, *J. D. Stephenson*, Westinghouse Electric Corporation, *W. L. Roark*, Avondale Mills, *K. A. Richardson*, Bibb Manufacturing Company, *R. C. Lathem*, Georgia Institute of Technology, and a representative from the General Electric Company

Official Nominees Announced for 1954 AIEE National Election

A. C. Monteith, vice-president in charge of engineering, Westinghouse Electric Corporation, Pittsburgh, Pa., was nominated for the AIEE presidency by the AIEE Nominating Committee at its meeting held in New York, N. Y., January 19, 1954. Others nominated for election to Institute offices for terms beginning August 1, 1954, are

For Vice-President:

G. J. Crowdes, chief engineer, Simplex Wire and Cable Company, Cambridge, Mass. (District 1)

J. P. Neubauer, division engineer, electrical engineering department, Consolidated Edison Company of New York, Inc., New York, N. Y. (District 3)

Claude M. Summers, engineer, works laboratory, General Electric Company, Fort Wayne, Ind. (District 5)

S. M. Sharp, vice-president and chief engineer, Southwestern Gas and Electric Company, Shreveport, La. (District 7)

John R. Walker, regional power manager, U. S. Bureau of Reclamation, Billings, Mont. (District 9)

For Directors:

L. F. Hickernell, chief engineer, Anaconda Wire and Cable Company, Hastings-on-Hudson, N. Y.

Roy E. Kistler, transmission and protection engineer, Pacific Telephone and Telegraph Company, Seattle, Wash.

Edwin S. Lammers, Jr., electronics engineering supervisor, Westinghouse Electric Corporation, Atlanta, Ga.

For Treasurer:

Walter J. Barrett, electrical co-ordination engineer, New Jersey Bell Telephone Company, Newark, N. J.

The Nominating Committee, in accordance with the Constitution and Bylaws, consists of 20 members, one selected by the executive committee of each of the ten geographical Districts, one selected by each of the five technical divisions, and five selected by the Board of Directors from its own membership.

The Constitution and Bylaws of the Institute require publication in *Electrical Engineering* of the nominations made by the Nominating Committee. Provision is made for independent nominations as indicated in the following excerpts from the Constitution and Bylaws:

Constitution: Section 32. Independent nominations may be made by a petition of twenty-five (25) or more corporate members sent to the Secretary when and as provided in the Bylaws; such petitions for the nomination of Vice-Presidents shall be signed only by members within the District concerned.

Bylaws: Section 24. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with Article VI, Section 32 (Constitution), must be received by the secretary of the Nominating Committee not later than March 25 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the Nominating Committee in accordance with Article VI of the Constitution and sent by the secretary to all qualified voters on or before April 15 of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

A list of members of the Nominating Committee appeared in the February issue of *Electrical Engineering*, page 174.

To enable those Institute members not acquainted personally with the nominees to learn something about their engineering careers and their qualifications for the Institute offices to which they have been nominated, brief biographical sketches are scheduled for inclusion in the "AIEE Personalities" columns of the April issue.

Conference on Electric Welding Scheduled for Milwaukee in May

The fourth Conference on Electric Welding under the sponsorship of the AIEE in co-operation with the American Welding Society, has been scheduled for Milwaukee, Wis., May 19–21, 1954, at the Hotel Schroeder. The conference is being arranged by the AIEE Committee on Electric Welding. A full program of papers on electric welding and inspection of welding processes in Milwaukee plants will be featured at the 3-day meeting.

The program will include sessions on resistance welding, inert gas arc welding, fundamental arc research, instrumentation, and safety. In addition, a number of inspection trips through local industrial plants are being planned. On the evening of May 20, members will be entertained by one of the city's large breweries.

E. J. Limpel, chairman of the Committee on Electric Welding, will be in charge of the conference. His executive committee consists of the following: A. U. Welch, papers; H. W. Tietze, publications; R. E. Young, publicity; R. J. Krieger, secretary; C. E. Pflug, conference treasurer; J. W. Brown, local chairman.

Second Conference Announced on Feedback Control Systems

Recognizing the need for bringing together engineers from the various fields which do or could use feedback controls, the AIEE will hold its Second Conference on Feedback Control Systems at the Claridge Hotel in Atlantic City, N. J., April 21–23, 1954.

The conference will feature technical papers which show the practical application of feedback control in the fields of aircraft controls, industrial controls, machine tool controls, process controls, computers, and nucleonic controls. In addition, other papers will describe test equipment and components used in feedback control engineering.

A unique feature of the conference will

be a series of demonstrations of equipment in the afore-mentioned fields. These demonstrations are scheduled to be presented in special periods devoted to that purpose. Also scheduled for presentation are addresses by F. E. Crever of the General Electric Company, chairman of the AIEE Committee on Feedback Control Systems, Dr. Gordon S. Brown of the Massachusetts Institute of Technology, and Dr. Louis N. Ridenour of the International Telemeter Corporation.

The conference registration fee of $3.00 will include a booklet containing abstracts of the technical papers and descriptions of the demonstrations. The conference proceedings, containing complete texts of the technical papers and descriptions of the demonstrations, is scheduled for publication after the conference at a price of $3.50.

Aerial view of the General Electric Research Laboratory, scheduled for inspection during the North Eastern District Meeting

North Eastern District Meeting Will Feature Nucleonics Sessions

A well-rounded program of technical papers has been scheduled for the AIEE North Eastern District Meeting to be held at the Hotel Van Curler, Schenectady, N. Y., May 5–7, 1954. Included in the program will be papers covering various aspects of power generation, transmission and distribution, transformers and capacitors, rotating machinery, and semiconductors, as well as magnetic amplifiers, control systems, and transportation equipment. Papers designed to illustrate application of instruments and measurements, computers, and research in engineering also will be presented. In addition, one day of the meeting, May 7, will be devoted to special sessions featuring papers covering developments in the field of nucleonics.

To supplement the technical program, inspection trips have been scheduled tentatively to the Albany Steam Plant of the Niagara Mohawk Power Company, the Turbine Manufacturing Plant of the General Electric Company, the General Electric Research and Knolls Atomic Power Laboratories, the American Locomotive Works, and the Bell Telephone Company.

ENTERTAINMENT

The smoker on May 5 will include a social hour and dinner, after which Dr. Murray Bank, lecturer in psychology, is scheduled to appear.

On the evening of May 6, preceding the Steinmetz Lecture, a dinner will be held at Union College.

A headquarters room at the Hotel Van Curler will be maintained for the ladies attending the meeting. An afternoon tea, dinner, and card party are planned for their entertainment on May 5. On Thursday, May 6, the ladies will tour the historic points of interest in the area. For May 7, a tour of the General Electric Research Laboratory, followed by a luncheon, has been scheduled.

ACCOMMODATIONS

Rooms have been set aside at the Hotel Van Curler for members and guests. Requests for reservations should be sent prior to April 20, 1954, to John Fors, Van Curler Hotel, Schenectady, N. Y., and should mention the AIEE meeting. Mr. Fors will coordinate all hotel reservations. In view of the large number of double rooms available, to insure reservations at the headquarters hotel and make use of available facilities, members and guests are urged to request double accommodations wherever possible. It may be necessary to transfer some reservations to other local hotels.

COMMITTEES

Members of the North Eastern District Meeting Committee are as follows: D. E. Garr, general chairman; W. Scott Hill, vice-chairman; G. J. Crowdes, secretary; W. A. Hunter, treasurer; E. S. Lee and P. L. Alger, counselors; L. T. Rader, H. C. Anderson, C. C. Herskind, L. F. Lewis, R. K. Fairley, and D. S. Brearton, members-at-large; R. Cutts, Jr., finance; L. A. Umansky, technical programs; A. K. Raney, publicity; Owen G. Owens, student activities; R. W. McFall, hotel arrangements; K. K. Bowman, registration; J. C. White, smoker and social hour; B. R. Shepard, printing and tickets; E. W. Hutton, banquet; W. R. Kettenring, trips and transportation; Mrs. W. C. White, ladies program.

Vannevar Bush Honored at Stanford Institute Luncheon

Dr. Vannevar Bush (F '24, HM '49), president of the Carnegie Institution of Washington, was honored by industrialists, civic leaders, and educators in the Southern California area at a luncheon sponsored on January 20, 1954, by the Stanford Research Institute (SRI). The event took place at the Statler Hotel in Los Angeles, Calif., and was presided over by F. B. Ortman, chairman of SRI's board of directors.

Holder of some 20 honorary degrees, 17 medals and awards, and 20 U.S. patents, Dr. Bush has held numerous positions of leadership in governmental scientific and research organizations and has written on a wide range of subjects. A graduate electrical engineer, he is also famed as an educator and administrator. In 1939–41 he was chairman of the National Advisory Committee for Aeronautics, in 1940 he was made chairman of the National Defense Research Committee, and a year later he was appointed director of the Office of Scientific Research and Development.

From 1942 to 1946 Dr. Bush was chairman of the Joint Committee on New Weapons and Equipment of the Joint U. S. Chiefs of Staff. From 1946 to 1947 he headed the Joint Research and Development Board, and from 1947 to 1948 he was chairman of the Research and Development Board of the National Military Establishment. He is a member of the Council on Foreign Relations.

Dr. Bush was the AIEE Edison Medalist for 1943.

K. B. McEachron Award to Go to High School Senior

An annual award is to be made to a deserving senior of the Pittsfield (Mass.) Technical High School as a memorial to the late Dr. K. B. McEachron. The selection of this type of memorial is based upon Dr. McEachron's interest in education and his very close interest in the establishment of the Technical High School. Those acquainted with his efforts in this field remember that he served as chairman of the technical advisory committee of the high school as well as being very active in promoting undergraduate study in University of Massachusetts Extension courses and graduate study at Renssalaer Polytechnic Institute.

The Fund is being sponsored by the community of Pittsfield in memory of his participation in many civic affairs.

Checks should be made payable to the Karl B. McEachron Memorial Fund and sent to Mr. J. H. Fryer at the Berkshire County Savings Bank, 24 North Street, Pittsfield, Mass.

Past Chairmen Honored by San Diego Section

Willis T. Johnson, California Electric Power Company, was the main speaker at the first annual Past Chairman's Night meeting of the AIEE San Diego Section on January 19, 1954. Mr. Johnson, who was Section chairman in 1943–44, was presented with his past chairman pin by A. H. Keith, the immediate past chairman. Mr. Johnson, in turn, presented each of the other attending past chairmen with their pins: W. L. Bryant (1940–41), Clem Nevitt (1941–42), Willis Kenline (1944–45), C. F. McCabe (1946–47), George Jenner (1947–48), Herbert Cordes

Past chairmen of the San Diego Section who received their pins at a recent Section meeting are, left to right: A. H. Keith, C. F. McCabe, W. L. Bryant, Ormus Doolittle, George Jenner, Clem Nevitt, Willis Johnson, Herbert Cordes, Paul Connor, Willis Kenline, and Joseph Sinott

(1948–49), Joseph Sinott (1949–50), Paul Connor (1950–51), and Ormus Doolittle (1951–52). Laurence Klauber, first honorary chairman in 1938, Frank Evenson (1939–40), and Bruce Gravitt (1942–43) were absent. R. Richey (1945–46) is deceased.

In his address, Mr. Johnson discussed the "Past, Present, and Future" of the California Electric Power Company. This company recently put into operation the first outdoor steam-electric generating plant in Southern California, the Highgrove station rated at 100,000 kw.

The present Section chairman, I. E. McDougal, presided at the meeting. In the absence of the program chairman, the speaker was introduced by E. F. Kotnik, the secretary-treasurer.

Preliminary Plans Outlined for Summer and Pacific Meeting

Current information on plans for the 1954 AIEE Summer and Pacific General Meeting, which is to be held at the Biltmore Hotel, Los Angeles, Calif., June 21–24, indicates a broad program of technical sessions, inspection trips, and social events in keeping with the widely diversified interests of members attending.

At present, the Institute's technical committees in the Communications Division are planning sessions on the following subjects: Communication Switching Systems, Radio Communications Systems, Telegraph Systems, Television and Aural Broadcasting Systems, and Wire Communications Systems.

In the Power Division sessions are being organized by the Committees on Carrier Current, Insulated Conductors, Power Generation, Protective Devices, Relays, Rotating Machinery, Substations, Switchgear, System Engineering, Transformers, and Transmission and Distribution.

In the Industry Division the Committees on Chemical, Electrochemical, and Electrothermal Applications, General Industry Applications, and Industrial Power Systems are planning three sessions. Within the General Applications Division, six sessions are projected for the meeting by the Committees on Air Transportation, Domestic and Commercial Applications, Land Transportation, and Production and Application of Light.

Eleven technical sessions are being organized in the Science and Electronics Division by the committees on Computing Devices, Electrical Techniques in Medicine and Biology, Electronics, Instruments and Measurements, Magnetic Amplifiers, and Nucleonics.

For those who are interested in electric power generation, trips are planned for visits to three new steam-electric generating plants and two transmission substations.

One of these is the newly constructed steam-electric generating station of the California Electric Power Company, located at Highgrove between San Bernardino and Riverside, Calif. This station, with a name-plate rating of 100,000 kw, is one of the most completely "outdoor" steam-electric generating plants on the West Coast. All components, with the exception of the operator's control and switchgear rooms, are located in the open. There are only two operating levels, at grade and at 14 feet, which results in easier and more economical maintenance and increases earthquake resistance.

For those whose interest lies in the field of electronics, trips are being planned to Pacific Telephone and Telegraph Company Communication Centers, where some of the latest advancements of the communication art will be seen; to a nationally known manufacturing plant where electronic components are produced; and to the radio and television centers in the area.

A trip is planned also for members who are interested in computers. The aircraft industry is making extensive use of these complex devices to solve many of its problems, and an inspection trip is tentatively planned to one of the outstanding installations.

For the industrial engineer, trips are being considered to a fruit processing plant, and to an aircraft manufacturing plant in this center of the airplane industry, where some of the most modern industrial methods may be seen.

The ladies will find their time fully occupied. A luncheon at the exclusive Wilshire Country Club and a trip to the beaches will be features of the ladies' program.

The 1954 General Meeting Transportation Committee welcomes inquiries with regards to routing by rail, air, or automobile to Los Angeles, to enable the members and their families to take maximum advantage of the trip to the Pacific Coast. Information may be secured by writing to Bradley Cozzens, General Chairman, AIEE Summer and Pacific General Meeting; Los Angeles Department of Water and Power, Post Office Box 3669, Terminal Annex, Los Angeles 54, Calif.

Highgrove Steam Plant of the California Electric Power Company, one of the most completely "outdoor" steam-electric generating plants on the West Coast, is scheduled for inspection during the Summer and Pacific General Meeting

AIEE, IRE Los Angeles Sections Hold Joint Dinner Meeting

At the Joint Dinner Meeting of the Los Angeles Sections of the AIEE and the Institute of Radio Engineers (IRE) held on January 5, 1954, in Los Angeles, Calif., the latest developments in magnetic television tape recording were presented by J. T. Mullin, chief engineer, Electronics Division, Bing Crosby Enterprises.

More than 250 members of both Sections attended the dinner, at which IRE Section Chairman Ellis King, chairman of the joint meeting, introduced the IRE Section officers, and AIEE Section Chairman C. A. Wells introduced the AIEE Section officers present.

In his address, Mr. Mullin described the early work in the development of the Ampex Electric Corporation high-quality tape recorders, which had been preceded by de-

velopment by the Germans during the war years. Mr. Mullin had discovered this information while serving as a technical liaison officer, Office of Chief Signal Officer, in Europe.

The discussion was illustrated with slides showing the principles of the various components, and a picture of one of the first models of the complex equipment necessary to record television signals was shown on the screen.

Committee Appointed for 1956 Summer and Pacific Meeting

According to a recent announcement, President Elgin B. Robertson has appointed members of a 1956 Summer and Pacific General Meeting Committee to make plans for the meeting to be held in San Francisco, Calif., June 25–29, 1956.

The committee will include James S. Moulton, chairman; D. I. Anzini, vice-chairman; W. F. Poynter, treasurer; W. L. Carter, secretary; in addition to the District 8 Director, Vice-President, and the following chairmen of the auxiliary committees: James A. Longley, arrangements; Arthur D. Bragg, entertainment; W. F. Poynter, finance; J. C. Beckett, hotel; I. W. Collins, inspection trips; Mrs. J. S. Moulton, ladies; F. J. Kovalcik, publicity; E. F. Sixtus, registration; O. A. Gustafson, sports; Professor T. C. McFarland, students; R. H. Miller, technical program; George E. Hulstede, transportation.

Missouri Mines Branch Sponsors Inspection Trip

On December 17, 1953, the Joint AIEE–Institute of Radio Engineers (IRE) Student Branch at the Missouri School of Mines, Rolla, sponsored a 2-day trip to the General Electric Company's receiving tube manufacturing plant at Owensboro, Ky. Ten students took the trip, which was made possible through the efforts of Professor R. E. Nolte, IRE representative of the Branch, and R. L. Hanna of the General Electric Company. They were shown the complete procedure of making vacuum tubes, from the design and development to the actual manufacture and testing of the finished product. The Owensboro plant is the largest single receiving tube manufacturing plant in the world.

At the regular meeting of the Joint Student Branch for December, J. O. Grantham, Phillips Petroleum Company, presented a talk entitled, "Wider Horizons for Engineers." At the January meeting, J. Somerville of the General Electric Company gave a lecture with slides and literature on "The Development and Use of Reliable Vacuum Tubes."

National Telemetering Conference Will Be Held in Chicago in May

The 1954 National Telemetering Conference and exhibits under the joint sponsorship of the AIEE, the Institute of Radio Engineers, the Institute of the Aeronautical Sciences, and the Instrument Society of America will be held at the Morrison Hotel, Chicago, Ill., May 24–26.

This year's meeting promises to provide subject matter of wider scope and deeper interest as a result of a considerable amount of missile telemetering and remote-control information recently developed.

W. J. Mayo-Wells of the Applied Physics Laboratory of Johns Hopkins University is chairman of the meeting. Charles Doersam, formerly of the Office of Naval Research and now with Sperry Gyroscope Company, is program chairman, and Kipling Adams of the General Radio Company is in charge of local arrangements and serves as vice-chairman.

AIEE PERSONALITIES.....

J. K. Nunan (AM '39, M '47), executive vice-president, Consolidated Vacuum Corporation, Rochester, N. Y., has been elected president of the company. Mr. Nunan was named executive vice-president of the firm early in 1953. Prior to becoming associated with Consolidated Engineering Corporation in February 1952 as vice-president in charge of sales, Mr. Nunan was employed by Howard Hughes, acting on direct assignment in matters relating to Hughes Aircraft, Hughes Tool Company, RKO-Radio Pictures Corporation, and Trans World Airlines. Before joining the Hughes organization, he served as general manager of the motion picture department, Ansco Division, General Aniline and Film Corporation, successfully introducing the Ansco color process to the motion picture industry in 1936. A former assistant dean of engineering and assistant professor of electrical engineering at the University of Southern California, Los Angeles, Mr. Nunan was an electrical engineering graduate of that university and subsequently was awarded a masters degree in electrical engineering from California Institute of Technology. During World War II, Mr. Nunan was awarded the Medal for Merit for his work on submarine development and as director of the Pearl Harbor Laboratory of the Columbia University Division of War Research. He is a member of Tau Beta Pi, Sigma Xi, and Eta Kappa Nu and has served on the AIEE Committee on Electronics (1948–50).

A. C. Monteith (AM '25, F '45), vice-president in charge of engineering, Westinghouse Electric Corporation, Pittsburgh, Pa., has been named an honorary member of The American Society of Mechanical Engineers "for his leadership in planning engineering developments, and particularly for his influence on the training of young engineers." A graduate of Queen's University, Kingston, Ont., Canada, Mr. Monteith went to Westinghouse at Pittsburgh as a student engineer. He became manager of the central station engineering department in 1938. In 1941 he was named manager of the industry engineering department and 4 years later took over the dual position of manager of headquarters engineering departments and director of education. He became vice-president in charge of engineering in 1948. He received the Westinghouse Order of Merit in 1940 and an honorary doctor of laws degree from Queen's University in 1948. Mr. Monteith has been active on the Engineering Manpower Commission of the Engineers Joint Council and several other engineering organizations. He is a member of The American Society of Mechanical Engineers and has been a most active member of the AIEE, having served as director (1947–51) and on many committees.

J. R. North (AM '21, F '41), chief electrical engineer, Commonwealth Associates, Inc., Jackson, Mich., has been awarded a certificate of service by the American Standards Association in recognition of his work in the development of American Standards. Mr. North was cited "in recognition of contributions to the democratic processes leading to the establishment of voluntary standards and in appreciation of sound advice and devotion of energy to the furtherance of the standards movement as a means of advancing the national economy." Mr. North represents the AIEE on the Standards Council and has been especially active on the Committee on Insulators for Electric Power Lines. He is also an electric light and power group representative on the Committee for Transformers, Regulators, and Reactors, and the Committee for Lightning Arresters. Mr. North is a former director (1945–49) and vice-president (1950–52) of the AIEE and has served on many committees of the Institute including Protective Devices, Electrical Machinery, Technical Program, Standards, Planning and Co-ordination, Air Transportation, Edison Medal, Switchgear, Publication, Technical Operations, and Executive.

E. E. Thomas (AM'13, F'51, Member for Life), consulting engineer, International General Electric Company, Schenectady, N. Y., retired January 31, 1953. Mr. Thomas was graduated from Purdue University in 1910 with a bachelor of science degree in electrical engineering and received the electrical engineer degree in 1913 from the same school. He joined General Electric in 1910 as a student engineer and did special assignments under Dr. C. P. Steinmetz. He was assigned to the synchronous convertor design section in 1913. Mr. Thomas went with the testing bureau of the Brooklyn Rapid Transit Company in 1914. He joined the Bailey Meter Company, Boston, Mass., in 1916, and later was field engineer for the H. M. Hope Engineering Corporation, Boston. He rejoined General Electric in Philadelphia, Pa., in 1917 and was transferred to Schenectady in 1920 to act as guarantee engineer on electric drives of merchant ships. In 1923 he spent 6 months on design of steam turbine generators before being transferred to the power section of the industrial engineering department where he did application engineering on

power generation, transmission, distribution, and conversion in many industries for 22 years. Oil field and oil refinery power application engineering work took him to California, Colombia, Venezuela, Aruba, Curacao, Trinidad, Peru, Ecuador, Bolivia, Chile, Argentina, Brazil, Mexico, Sumatra, and Saudi Arabia. During 1943 he worked on power application to the Big Inch and Little Big Inch pipe lines. Mr. Thomas transferred to the International General Electric Company in 1945. He is a member of The American Society of Mechanical Engineers and the New York Society of Professional Engineers. He now is doing consulting engineering.

D. C. Hopper (AM '18, Member for Life), professional distribution engineer, transmission and distribution department, Duquesne Light Company, Pittsburgh, Pa., retired December 1, 1953, after over 30 years' service. Mr. Hopper received his electrical engineering degree from the University of Arkansas in 1915 with postgraduate work at the Chicago Central Station Institute. He has been employed successively by Union Switch and Signal Company, Commonwealth Edison Company, American International Shipbuilding Corporation, Newport News and Hampton Railway Gas and Electric Company (now Virginia Electric and Power Company), Northern Ohio Traction and Light Company (now Ohio Edison Company), and joined the Duquesne Light Company in 1923 as assistant to general superintendent. Two years later he was named superintendent of overhead lines construction and in 1929 was made distribution engineer. He has been engaged in electrical construction and design of overhead and underground transmission and distribution lines throughout his career.

J. F. Ward (M '49), superintendent, Lighting Division, City of Tacoma, Wash., has been named managing director of the Washington State Power Commission, Tacoma. Mr. Ward has been superintendent of Tacoma City Light for 7 years, since 1947. Prior to that time he was manager of the Puget Sound District of the Bonneville Power Administration in Seattle, Wash., from 1940 to 1947 and was engineer in charge of all transmission line construction from 1938 to 1940. Between 1918 and 1938 Mr. Ward had 20 years' extensive and varied general and electrical construction experience, including 4 years as vice-president of the Rounds-Clist Company and 6 years as president of his own construction firm, both in Seattle. Mr. Ward is a graduate of Northwestern University and is a past president and director of the American Public Power Association and a member of the Northwest Public Power Association.

C. C. Chambers (AM '35, F '51), dean, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, has been appointed vice-president in charge of engineering affairs of the university. Dr. Chambers will direct the university's educational activities in chemical, civil, electrical, mechanical, and metallurgical engineering. Dr. Chambers has headed the Moore School faculty since 1949—as acting dean until 1951, since then as dean. He joined the teaching staff in 1933. He earned the degree of bachelor of science at Dickinson College in 1929 and the degree of doctor of science in engineering at Pennsylvania in 1934. During World War II he was educational director of Moore School's Engineering Science Management War Training Program. He also organized and operated a research project of the Office of Strategic Services. He has been research director or consultant in several industrial concerns. Dr. Chambers is serving as a Liaison Representative on the Standards Committee of the AIEE.

Crosby Field (AM '14, F '22, Member for Life), president, Flakice Corporation, Brooklyn, N. Y., was awarded The American Society of Mechanical Engineers medal for distinguished service in engineering and science. Mr. Field was cited as one who "has established and expanded industries and made invaluable contributions to improved designs and production techniques in many fields." Mr. Field holds more than 100 U.S. patents including those for machinery for the manufacture of steel and other metal wool, and a method of making small ice which led to the formation of the Flakice Corporation. He was active in U. S. Army Ordnance during both World Wars, attaining the rank of colonel. In 1946 he was awarded the Legion of Merit for engineering analysis in reducing hazards in the explosives industry. A graduate of New York University, he holds a masters degree from Cornell University and the master of science and electrical engineer degrees from Union College. He is a member of The American Society of Mechanical Engineers.

L. S. Harrison (M '19), consulting engineer, Metropolitan Museum of Art, New York, N. Y., retired January 1, 1954. The trustees of the museum have elected Mr. Harrison an honorary fellow for life. Mr. Harrison, formerly with the General Electric Company and International Business Machines Corporation in various engineering and executive capacities joined the staff of the museum in 1940 to develop requirements, co-ordinate planning, and direct construction of the museum's long-range reconstruction program. Specializing in the development of museum gallery lighting, Mr. Harrison conducted extensive experiments at the museum from 1948 to 1950, resulting in substantial contributions to lighting techniques in the museum field. Mr. Harrison will devote himself during retirement to research and part-time consulting work in the lighting and allied fields.

L. M. Klauber (AM '11, F '23, Member for Life), chairman of the board and chief executive officer, San Diego (Calif.) Gas and Electric Company, retired January 1, 1954. Mr. Klauber, however, will continue as a member of the board of directors. His retirement ends 43 years of service with the utility. Starting as a salesman in 1911, he has served successively as engineer in charge of the engineering department, superintendent of the electric department, general superintendent, vice-president in charge of operation, and vice-president and general manager. He was elected president in 1946 and became chairman of the board in 1949. Mr. Klauber has served as president of both the Pacific Coast Electrical and Gas Associations and as a director of the Edison Electric Institute. He has served on the AIEE Committee on Transmission and Distribution (1921–25).

A. D. Knowlton (M '36, F '50), director of facilities development, Bell Telephone Laboratories, New York, N. Y., has been appointed director of design engineering. Mr. Knowlton is a veteran of more than 33 years of Bell System service. In 1920, shortly after graduating from Haverford College, he joined the Western Electric Company's engineering department, which was incorporated as Bell Telephone Laboratories in 1925. He has specialized in the field of design of Bell System equipment and systems, including manual switchboards, teletypewriter switchboards, telegraph equipment, and transmission systems, as well as radar equipment. In 1950 he was appointed director of systems engineering and in 1951 to his present post as director of facilities development. Mr. Knowlton is a senior member of the Institute of Radio Engineers.

E. B. Paxton (AM '22, M '25), executive department, General Electric Company, Schenectady, N. Y., has been awarded a certificate of service by the American Standards Association in recognition of his work in the development of American Standards. Mr. Paxton's citation read: "The American Standards Association presents this certificate in recognition of contributions to the democratic processes leading to the establishment of voluntary standards and in appreciation of sound advice and devotion of energy to the furtherance of the standards movement as a means of advancing the national economy." Mr. Paxton represents the AIEE on the Standards Council. He has served on the AIEE Committees on Electrical Machinery (1925–27, 1928–34, 1935–38) and Standards (1931–54, Chairman, 1950–52).

H. W. Lovett (AM '53), industrial sales manager, Roller-Smith Corporation, Bethlehem, Pa., has been appointed industrial and switchgear sales manager. Mr. Lovett was graduated in electrical engineering from Lafayette College and took postgraduate training including advanced studies in Milwaukee, Wis., where he received practical experience in the shops as well as in the sales and engineering offices of the Allis-Chalmers Manufacturing Company. Mr. Lovett has been in the sales and engineering departments of the Roller-Smith Corporation for 15 years. He was in charge of the corporation's installation of equipment for the Panama Canal and has handled many of its governmental, utility, and industrial transactions.

L. A. Kilgore (AM '29, F '45), assistant manager, generator engineering, Transportation and Generator Division, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed staff engineering manager for the East Pittsburgh Divisions of the

corporation. In his new post, Mr. Kilgore will direct the engineering aboratories and help direct the design and development work of the electric generating and distribution apparatus produced at the plant. Mr. Kilgore has served on the following AIEE committees: Electrical Machinery (1938–47, Chairman, 1944–46); Standards (1944–46); Technical Program (1944–46); Award of Institute Prizes (1944–46); Rotating Machinery (1947–48); and Power Generation 1948–50, 1953–54).

J. W. St. Andre (AM '43, M '48), electrical editor, *Factory Management and Maintenance*, McGraw-Hill Publishing Company, New York, N. Y., has been appointed director of public relations, Anderson-Nichols Company, Boston, Mass. Mr. St. Andre was formerly with the General Electric Company. From 1931 to 1935 he served with the Merchant Marine. During the war he was electrical engineer and later became general maintenance superintendent for Wright Aeronautical Corporation, Woodrige, N. J. Prior to joining McGraw-Hill in 1951, he was corporation chief electrical engineer, General Cable Corporation, Perth Amboy, N. J. Mr. St. Andre is serving on the AIEE Committee on Industrial Power Systems (1953–54).

John Drollinger, Jr. (AM '49), manager, branch sales office, Reliance Electric and Engineering Company, Toledo, Ohio, has become manager of the Renewal Parts and Repair Division, Cleveland, Ohio. **R. O. Gee** (AM '50), application engineer, applied engineering department, Cleveland, has become manager of service. With Reliance since 1948, Mr. Drollinger was assigned to the company's Detroit (Mich.) sales office the following year. A native of Akron, Ohio, he received his degree in electrical engineering from the University of Michigan. Mr. Gee has been associated with the company's applied engineering department since 1950. He is a graduate of Purdue University.

Theophilus Johnson, Jr. (AM '18), manager, carrier current sales department, General Electric Company, Schenectady, N. Y., has been appointed sales manager for carrier current equipment. A native of New York City, Mr. Johnson is a graduate of Columbia University with an electrical engineering degree. He has been with General Electric for 33 years, serving in the original radio department of the company. He has been engaged in carrier current activities since 1921. Mr. Johnson has served on the AIEE Committee on Communication (1931–37).

F. G. York (AM '48), planning and distribution engineer, Ottawa Hydro-Electric Commission, Ottawa, Ont., Canada, has become acting manager. Mr. York has been associated with the Ottawa Commission since 1926. After receiving his university degree, he joined the permanent staff, working as a substation operator and line foreman until 1938 when he became distribution superintendent. Following the acquisition of the Ottawa Light, Heat, and Power Company by the commission, he was appointed planning and distribution engineer.

J. F. Reintjes (AM '40), associate professor of electrical engineering, Massachusetts Institute of Technology, Cambridge, has been appointed director of the Servomechanisms Laboratory of the department of electrical engineering. Professor Reintjes was born in Troy, N. Y., in 1912 and received the degrees of electrical engineer in 1933 and master of electrical engineering in 1934 from Rensselaer Polytechnic Institute. He first joined the Massachusetts Institute of Technology staff in 1943 as a visiting professor of electrical communications in the wartime Radar School. Prior to that time he had been a member of the faculty at Manhattan College and an engineer with the General Motors Corporation. Following his 2-year term on the staff of the Radar School, he served as an engineer with the General Electric Company. In 1947 he was named assistant professor of electrical engineering at Massachusetts Institute of Technology. Professor Reintjes is a senior member of the Institute of Radio Engineers and a member of the American Society for Engineering Education.

H. W. Tenney (M '36, F '43), general manager of manufacturing operations, Westinghouse Elevator Division, Jersey City, N. J., has been appointed administrative assistant to the vice-president of the division. Born in Leominster, Mass., Mr. Tenney graduated from Worcester Polytechnic Institute in 1920 and joined Westinghouse the same year as a laboratory assistant in the research department. In 1936 he became manager of the central engineering laboratories and in 1937 was named engineering manager of the new products division. He became assistant director of the research laboratories in 1940 and 3 years later was appointed assistant to the vice-president in charge of the Westinghouse East Pittsburgh divisions. In 1945 Mr. Tenney was awarded the Westinghouse Order of Merit. He was appointed general manager of manufacturing operations for the Elevator Division in 1947. Mr. Tenney has served on the following AIEE committees: Research (1942–45); Charles LeGeyt Fortescue Fellowship (1943–46); Safety (1944–46); and Board of Examiners (1950–54).

L. D. Stevens (AM '50), technical assistant to the manager, San Jose (Calif.) Laboratory, International Business Machines Corporation, has been promoted to the position of development engineer at the same location. Mr. Stevens received his bachelor of science degree from Texas Technological College and his masters degree from the University of California, where he also served as a teaching assistant. He joined International Business Machines in 1949 in Poughkeepsie, N. Y., and was transferred to San Jose in 1953. He is a member of the Institute of Radio Engineers, Sigma Xi, and the Association for Computing Machinery.

E. H. Fredrick (AM '38, M '46), chief application engineer, Dynamatic Corporation, Kenosha, Wis., has been appointed assistant general manager of the corporation, a subsidiary of the Eaton Manufacturing Company of Cleveland, Ohio. He was graduated from Marquette University in 1931 and later served as sales engineer with the Allis-Chalmers Manufacturing Company, Milwaukee, Wis. In 1949 he joined Dynamatic as chief application engineer. He is a past chairman of the AIEE Milwaukee Section and currently is serving on the AIEE Committee on Rotating Machinery.

I. F. Kinnard (AM '21, F '43), manager of engineering, meter and instrument department, General Electric Company, West Lynn, Mass., has been awarded an honorary doctor of science degree by Queens University, Kingston, Ont., Canada. Dr. Kinnard, who is on the university's advisory council for applied science, was honored for his professional engineering accomplishments and his efforts to develop the engineers and scientists of the future. The Lamme Medalist for 1953, Dr. Kinnard has served on the following AIEE committees: Instruments and Measurements (1927–47, Chairman, 1939–41); Technical Program (1939–41); Board of Examiners (1946–50); Research (1953–54).

T. G. Wilson (AM '50), United States Naval Research Laboratory, Washington, D.C., has joined the engineering development staff of Magnetics, Inc., Butler, Pa. Dr. Wilson received his doctorate in electrical engineering from Harvard University. After working on equipment design for supersonic wind tunnel measurements for the Naval Ordnance Laboratory, he became associated with the Naval Research Laboratory where he spent more than 4 years on basic and applied research on magnetic amplifiers.

J. R. Staller (AM '49), switchgear engineer, Roller-Smith Corporation, Bethlehem, Pa., has been designated chief engineer for switchgear and bus structures. Mr. Staller was graduated from Lehigh University in 1935 and has served in the design and production engineering departments of Roller-Smith for more than 16 years. He recently has been in charge of the engineering phases of equipment being manufactured for contractors on atomic energy installations at Oak Ridge, Tenn.; Paducah, Ky.; and Portsmouth, Ohio. He is a registered professional engineer and is a member of the National Electrical Manufacturers Association.

Richard Taylor (M '41), project engineer in defense engineering, International Business Machines Corporation, Binghamton, N. Y., has been named manager of the newly organized medical equipment engineering department. A graduate, and later professor in electrical engineering, at the Massachusetts Institute of Technology, Cambridge, Mr. Taylor began his association with International Business Machines in 1951 as a technical engineer in the Endicott (N. Y.) development engineering laboratory. He later was assigned to defense engineering as a technical engineer, and was appointed project engineer in 1952.

M. H. Hobbs (M '37, F '48), assistant manager, Switchgear Division, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed manager of the division. A native of Yorkville, Ill., Mr. Hobbs came to the Westinghouse Switchgear Division in 1922 from the Montana Power Company. He was named manager of the

switchgear engineering department in 1944 and assistant manager of the division in March 1953. In 1943 Mr. Hobbs received the Westinghouse Order of Merit for distinguished service in designing vital electric equipment for war industries and the Armed Forces. He was graduated from the University of Kansas, where he received a bachelor of science degree in electrical engineering in 1913. During World War I he served overseas with the United States Army as a second lieutenant. Mr. Hobbs has served on the AIEE Committees on Protective Devices (1944–45); Switchgear (1947–54); and Safety (1948–49).

E. L. Hough (AM '25, F '48), chief engineer, Union Electric Company of Missouri, St. Louis, has been elected a vice-president of the company. He also has been reappointed to his present post, which he has held since 1951. After graduation from the University of North Dakota in 1922 with a bachelor of science degree in electrical engineering, Mr. Hough spent 6 years with the General Electric Company, Schenectady, N. Y., before joining the Union Electric Company in 1928 as an electrical engineer. He was made chief design engineer in 1928. Mr. Hough has served on the AIEE Committees on Automatic Stations (1929–30) and Power Generation (1947–49).

F. M. Winterhalter (AM '45), engineer-in-charge of a-c design, electrical section, Allis-Chalmers Norwood (Ohio) Works, has been appointed chief engineer of the section. Mr. Winterhalter has been an Allis-Chalmers employee since his graduation in 1936 from the University of Cincinnati. He was placed in charge of a-c design in 1949.

J. J. Shoemaker (AM '15, M '20), engineer of safety and fire protection, production department, Detroit (Mich.) Edison Company, has joined the staff of the Hinchman Corporation, Engineers, of Detroit. A graduate of Iowa State College, Mr. Shoemaker is a registered professional engineer in Michigan and is a past chairman of the AIEE Michigan Section. He has served on the following AIEE committees: Sections (1932-34); Membership (1939-40); Power Division (1953–54); and Safety (1953–54).

J. A. Hartshorn (AM '47), lieutenant (junior grade), United States Naval Reserve, New York, N. Y., has been appointed apparatus engineer for the Eastern Division of the Line Material Company, with headquarters in Revere, Mass. A registered professional engineer in Massachusetts, he received his bachelor of science degree in electrical engineering from Tufts College in 1945

R. F. Lamb (AM '51), manufacturer's representative, Potter and Brumfield, Princeton, Ind., has been appointed to handle the company's business in the Buffalo, N. Y., area. A graduate of the University of Minnesota, Mr. Lamb formerly was associated with Esterline-Angus as a sales and application engineer.

R. E. Markle (AM '52), technician in the Endicott (N. Y.) electrical engineering laboratory of the International Business Machines Corporation, has been appointed technical engineer at the same location. Mr. Markle was graduated from Pennsylvania State College and became associated with International Business Machines in 1951. He is a member of Eta Kappa Nu.

G. M. Hoffman (AM '30), assistant chief electrical engineer, Peter F. Loftus Corporation, Pittsburgh, Pa., has been appointed project engineer for Trion, Inc., McKees Rocks, Pa. He is a graduate of the Massachusetts Institute of Technology and a registered professional engineer in New York and Pennsylvania. He is a member of the Association of Iron and Steel Engineers.

I. W. Strong (AM '45), Denver (Colo.) sales representative, Appleton Electric Company, has been appointed assistant to the vice-president in charge of sales, with headquarters at the company's home office in Chicago, Ill. He is a graduate of Purdue University, and a registered professional engineer in Indiana.

D. W. Nurse (AM '50), resident manager of the Wilkes-Barre, Pa., plant, The Okonite Company, Passaic, N. J., has been made vice-president in charge of manufacturing for the company's three factories. Mr. Nurse joined Okonite in 1942 as a sales representative in the San Francisco, Calif., office, after several years in the electrical wholesaling field. In 1947, he was made manager of the Portland, Oreg., district office, and in 1950 he was transferred to Wilkes-Barre as assistant sales manager, becoming factory sales manager in the same year. He was made resident sales manager in 1953.

H. S. Farmilo (AM '48), sales engineer, distribution assemblies department, General Electric Company, Philadelphia, Pa., has been named manager of the Philadelphia sales district for the department. Mr. Farmilo has been a sales representative of the former Trumbull department since 1942 and has served in the Philadelphia area for the past 10 years. A graduate of Detroit Technical School, he first became associated with General Electric in Schenectady, N. Y. He also has served as a power apparatus specialist with the General Electric Supply Company, Baltimore, Md., and as a field sales engineer with Chase Brass and Copper. He is a member of the Engineers Club of Philadelphia.

R. B. Scott (AM '41, M '52), sales engineer, General Electric Apparatus Sales Office, Omaha, Nebr., has been appointed manager of the Lincoln, Nebr., office. Mr. Scott graduated from the University of Kansas in 1940 with a bachelor of science degree in electrical engineering. After a year on the General Electric test program, he left to take an assignment with the United States Army Quartermaster Corps in Central America. Late in 1942 he rejoined General Electric and became affiliated with International General Electric. From 1943 to 1947 he was with the Washington, D. C., office and from there went to Brazil to handle sales assignments. In 1951 he returned to the United States and in February 1952 joined the Omaha office staff.

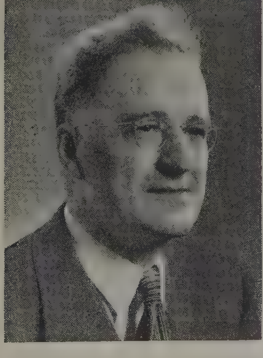
C. S. Lumley (AM '23, F '45), executive vice-president, H. E. Beyster and Associates, Inc., Detroit, Mich., has been made vice-president and general manager, Burns and Roe of Michigan, Inc., Detroit, a newly formed subsidiary of Burns and Roe, Inc., of New York, N. Y. Mr. Lumley received his engineering education in England, followed by post-graduate work at Columbia University. He has served previously as general manager of Roller-Smith Company, Bethlehem, Pa., and chief engineer and general manager of the Industrial Division and more recently as executive vice-president of H. E. Beyster and Associates, Inc. He is a charter member of the Engineering Society of Detroit and a member of the American Society for Testing Materials and the National Society of Professional Engineers.

OBITUARIES • • • •

Karl Boyer McEachron (AM '14, M '20, F '37, Member for Life), consultant—professional employee relations, General Electric Company, Pittsfield, Mass., died January 24, 1954. Dr. McEachron was a pioneer in lightning research for the General Electric Company. He was born in Hoosick Falls, N. Y., November 17, 1889, and graduated from Ohio Northern University in 1913 with degrees in both electrical and mechanical engineering. After a year with the General Electric Company devoted mainly to high-voltage investigations, he returned to Ohio Northern to become an instructor in electrical engineering from 1914 to 1918. For the next 4 years he was an instructor and research associate at Purdue University, Lafayette, Ind. In 1920 he received a master of science degree in electrical engineering from Purdue. Later, both universities granted him honorary doctorate degrees—Ohio Northern in 1938, Purdue in 1941. In 1922 Dr. McEachron joined the General Electric Company, Pittsfield, as head of the lightning arrester development and research section. In 1933 he was appointed engineer in charge of the High Voltage Engineering Laboratory. From 1940 until his appointment as assistant works engineer in 1945, Dr. McEachron was designing engineer of power transformers. In 1949 he was appointed manager of engineering, Transformer and Allied Products Division, a position he held until his appointment as consultant—professional employee relations in 1953. Dr. McEachron developed much of the modern technique of measurement of artificial and natural lightning and investigated the behavior of component insulations and complete transformers under various types of impulse voltage. The most widely known of his investigations was the study of lightning strokes to the tower of the

Empire State Building. Also developed under his direction was the 10,000,000-volt artificial lightning generator used at the New York World's Fair. Dr. McEachron had received the Edison Medal of the Institute for his contributions to the advancement of electrical science in the field of lightning and other high-voltage phenomena. He also had been awarded the Edward Longstreth Medal of the Franklin Institute in 1936 and the New England Award of the Engineering Societies of New England in 1952. Dr. McEachron was the inventor of Thyrite resistance material used in a variety of lightning protection and other applications. For this work he received the General Electric Coffin Award in 1931. He was a member of Eta Kappa Nu and was active in civic and community affairs. A very active member of the AIEE, Dr. McEachron had served as a director (1936–40) and as a vice-president (1942–44) and on the following committees: Basic Sciences (1926–32, 1936–41); Protective Devices (1926–28, 1933–42, Chairman, 1938–40); Edison Medal (1937–39, 1942–44, 1952–57); Technical Program (1938–40); Executive (1938–40); Standards (1939–45); Board of Examiners (1942–44); Lamme Medal (1942–45); Publication (1942–44, 1948–54, Chairman, 1949–53); Registration of Engineers (1942–52); Transfers (1943–46); Planning and Co-ordination (1949–54); Award of Institute Prizes (1949–52); Public Relations (1949–53); and Technical Operations (1952–54). Dr. McEachron's experiments in high voltages were of much more than laboratory interest; they had a high practical value. As a result of the research he carried out or supervised, it has been possible to design transmission lines that are relatively free from lightning trouble, as well as lightning-proof transformers and other electric apparatus.

Edwin Howard Armstrong (M '53, HM '53), professor of electrical engineering, Columbia University, New York, N. Y., died February 1, 1954. Major Armstrong was the inventor of frequency modulation (FM) and one of the nation's leading radio pioneers. Besides his invention of FM in 1935, which eliminated static and led to an increase in new stations, Major Armstrong invented the following three processes, all most important in radio development: the regenerative receiving circuit in 1913, the superheterodyne receiving circuit in 1917, and the superregenerative receiving circuit in 1922. Born in New York, N. Y., December 18, 1890, Major Armstrong graduated from Columbia University in 1913 with an electrical engineering degree. After serving as an assistant in the electrical engineering department at Columbia for a year, he became associated with M. I. Pupin, Hartley Research Laboratory, Columbia, in radio research on problem of elimination of static. During World War I, he served as captain and later major in the U. S. Army Signal Corps. From 1919 to 1933 he did research at Hartley Research Laboratory on the problem of reducing static in radio signaling. Since 1933 he had been professor of electrical engineering at Columbia. He received the honorary degrees of doctor of science from Columbia in 1929, Muhlenberg in 1941, and Laval in 1948. Among the many honors and awards which Major Armstrong had received were the Medal of Honor of the Institute of Radio Engineers in 1917, the Egleston Medal from Columbia University in 1939, the Holley Medal from The American Society of Mechanical Engineers in 1940, the National "Modern Pioneer" Award of the National Association of Manufacturers in 1940, the Franklin Medal of the Franklin Institute in 1941, the John Scott Medal from the Board of Directors of City Trusts, Philadelphia, Pa., in 1942, the Edison Medal of the AIEE in 1942, the Medal for Merit from the U. S. Government in 1947, and the Washington Award of the Western Society of Engineers in 1951. Major Armstrong was a Chevalier of the French Legion of Honor and a fellow of the Institute of Radio Engineers, the Institution of Radio Engineers, Australia, the Radio Club of America, and the Royal Society of Arts and Sciences, and a member of Sigma Xi and Tau Beta Pi.



Karl Boyer McEachron

Edwin Howard Armstrong

Paul Gough Agnew (AM '12, M '19, Member for Life), New York, N. Y., died January 8, 1954. Dr. Agnew had served as secretary of the American Standards Association (ASA) from 1920 until his retirement in 1947. One of the leaders in the formation of the ASA, Dr. Agnew had continued to serve as one of its leading consultants until 1951 and in the same year was named to receive the first Standards Medal given by the ASA in recognition of his contributions to standards work. He was born in Hillsdale County, Mich., July 3, 1881, and graduated from Hillsdale College in 1901. He received his masters degree in engineering from the University of Michigan and his doctorate from Johns Hopkins University in 1911. After serving as a physics instructor in Michigan high schools, he worked as a physicist for the National Bureau of Standards, Washington, D. C., before joining the American Engineering Standards Committee, predecessor to the ASA, shortly after it was organized in 1919. When the ASA came into being he went with it as a vice-president and secretary. Dr. Agnew helped lay the groundwork in London, England, in 1921, and in Zurich, Switzerland, in 1923 for the formation of the International Federation of National Standardization Associations. The organization was dissolved during World War II, and in 1946 Dr. Agnew helped found the present International Standardization Organization. Dr. Agnew had served on the following AIEE committees: Electrophysics (1918–20); Instruments and Measurements (1917–19); Standards (1916–20); Joint Power Factor (1919–20); and as a representative on the United States National Committee of the International Electrotechnical Commission (1919–23).

Benjamin Franklin Bailey (AM '07, M '13, F '21, Member for Life), professor emeritus of electrical engineering, University of Michigan, Ann Arbor, died January 8, 1954. Dr. Bailey was born on August 7, 1875, in Sheridan, Mich. He received his bachelor of science degree in electrical engineering in 1898, his masters degree in 1900, and his doctorate in 1907, all from the University of Michigan. In 1898 he was employed by the Edison Illuminating Company of Detroit as a designer. In 1899 he joined the General Electric Company as a member of the testing department. After 6 months he returned to the University of Michigan as an instructor in electro-therapeutics. In 1900 he was appointed instructor in electrical engineering at the university. He became assistant professor in 1906, junior professor in 1910, and professor in 1913. From 1925 until his retirement in 1945 he was chairman of the electrical engineering department. When he retired he was awarded the title of professor emeritus. In addition to his teaching Professor Bailey was very active as a consulting engineer. During the year 1908–09, while on leave from the university, he acted as chief engineer of the Fairbanks Morse Electric Manufacturing Company and remained in their employ as a consulting engineer until 1915. He was also a consulting engineer of the Howell Electric Motors Company and chief engineer, director, and one of the founders of the Bailey Electric Company, Grand Rapids, Mich. Dr. Bailey was the author of five textbooks and many technical papers. He invented the Bailey electric lighting starting and ignition system and the capacitor motor. Dr. Bailey was a member of the American Society for Engineering Education, Sigma Xi, Eta Kappa Nu, and Tau Beta Pi, and had served on the AIEE Committee on Electrical Machinery (1924–28).

Frederick A. Maxfield (AM '31, M '39), Given Manufacturing Company Research Laboratory, Washington, D. C., died November 6, 1953. Dr. Maxfield was born in Milwaukee, Wis., April 4, 1908. He received his bachelor of science degree and his

doctorate from the University of Wisconsin and his masters degree from the University of Pittsburgh. From 1929 to 1934 he worked with the Westinghouse Research Laboratory, returning to the University of Wisconsin in 1934 as a professor. He taught there until 1941. With the outbreak of World War II, Dr. Maxfield joined the Naval Ordnance Laboratory. One of his early jobs there took him to Pearl Harbor to work on degaussing materials which protected ships against magnetic mines. The Bureau of Ordnance of the Navy took him in 1943 to work on the acoustical torpedo. With an associate, he developed a prototype of the underwater missile which finds its prey by the noise of the ship's motors. Later he was chief civilian scientist in the underwater ordnance section of the bureau. Many of his ideas are embodied in the present acoustical torpedo. Late in 1952 Dr. Maxfield left the Bureau of Ordnance to establish the Given Manufacturing Company Research Laboratory, Washington. Dr. Maxfield received the Distinguished Service Award for his Navy work.

John Milton Dodds (AM '19, M '33), consulting engineer, General Electric Company, San Francisco, Calif., died December 3, 1953. Mr. Dodds was born in Chicago, Ill., March 31, 1892, and received his bachelor of science degree in electrical engineering from the University of Washington in 1915. Mr. Dodds had been with General Electric since 1915 except for 2 years during World War I when he served in the United States Navy as an electrical officer on the USS *Salem*. During World War II he supervised installations on naval ships on the West Coast for General Electric. In addition to his position with General Electric, Mr. Dodds taught evening classes at technical schools and for 5 years during World War II lectured on marine electricity and engineering at the University of California in the Engineering Science Management War Training Program. He was the author of three volumes on marine electricity and was a member of the Society of Naval Architects and Marine Engineers, the National Association of Power Engineers, and the Council of Engineers. He had served on the AIEE Committee on Membership (1941–43).

Charles D. Highleyman (AM '41, M '51), assistant superintendent of substations, Indiana and Michigan Electric Company, South Bend, Ind., died December 6, 1953. Mr. Highleyman was born in St. Louis, Mo., December 20, 1905, and graduated from the University of Wisconsin in 1927 with a bachelor of science degree in electrical engineering. Upon graduation he joined the General Electric Company in their test department at Erie, Pa., and was transferred to Schenectady, N. Y., in February 1928. In April of that year he entered the employ of the Indiana and Michigan Electric Company. He had served as relay engineer, general substation electrical engineer, and assistant superintendent of substations. Mr. Highleyman was a past chairman of the South Bend Section of the AIEE and had served on the Committee on Substations (1947–49).

James Donald Swafford (AM '28, M '49), electrical engineer, Delta-Star Electric Division, H. K. Porter and Company, Chicago, Ill., died October 20, 1953. Mr. Swafford was born in Excelsior Springs, Mo., April 11, 1907, and received his degree in electrical engineering from the University of Kansas in 1932. Mr. Swafford started as a laboratory tester for the Kansas City (Mo.) Power and Light Company in 1927. In 1935 he became electric meterman and serviceman for the Kansas Electric Power Company, Leavenworth. He was advanced to district engineer—Leavenworth District in 1938, electric distribution superintendent—Emporia District in 1942, and electrical engineer of the company in 1945. He was associated with Murray and Company, Kansas City, from 1947 to 1948 as an application and sales engineer. Mr. Swafford was electrical engineer for Black and Veatch Consulting Engineers, Kansas City, from 1948 until 1952 when he joined Delta-Star Electric. Mr. Swafford was a registered professional engineer and a member of the National Society of Professional Engineers.

Sanford Price (AM '45, M '52), engineer, Headman, Ferguson and Carollo, Phoenix, Ariz., died January 15, 1954. Mr. Price was born in Cleveland, Ohio, September 26, 1910, and attended Case School of Applied Science (now Case Institute of Technology). From 1929 to 1948 he was associated with Electric Controller and Manufacturing Company, Cleveland. His duties consisted of designing special industrial control equipment for use in steel mills, rubber mills, brass and aluminum rolling mills, mines, and municipal pumping stations. Since 1948 he had been with Headman, Ferguson and Carollo as an electrical designer and resident engineer on diesel plants, electric plants, and treatment plants.

Howard Carlisle Smith (AM '28), electrical designer, engineering department, Pacific Gas and Electric Company, San Francisco, Calif., died November 30, 1953. Mr. Smith was born in Palo Alto, Calif., September 27, 1902. After receiving electrical and mechanical engineering degrees at Stanford University, he worked for the California Oregon Power Company and the Southern California Edison Company. In 1930 he commenced work for the Pacific Gas and Electric Company, first in construction and then in the engineering department in electrical design work.

John Oscar Fuchs (AM '16, F '29, Member for Life), electric production manager, Central Hudson Gas and Electric Corporation, Poughkeepsie, N. Y., died in November 1953. Mr. Fuchs was born in Far Rockaway, N. Y., June 5, 1890, and graduated from Cornell University in 1911 with a degree in mechanical engineering. From 1911 to 1914 he was associated with J. G. White Engineering Corporation on construction work in Tennessee, Texas, and New York. He had been associated with Central Hudson Gas and Electric since 1914, except for his period of service in the U. S. Army during World War I. He had been production engineer, operating engineer, and general operating manager.

MEMBERSHIP • • •

Recommended for Transfer

The Board of Examiners at its meeting of January 14, 1954, recommended the following members for transfer to the grade of membership indicated. Any objections to these transfers should be filed at once with the Secretary of the Institute. A statement of valid reasons for such objections, signed by a member, must be furnished and will be treated as confidential.

To Grade of Member

Bachman, W. W., supervisor, military engg. dept., Motorola, Inc., Chicago, Ill.
Boone, J. J., division staff supervisor, American Tel. & Tel. Co., Philadelphia, Pa.
Brass, E. A., president, B & B Engineering Corp., Norwood, La.
Bundy, R. C., research engineer, Hughes Aircraft Co., Tucson, Ariz.
Chase, A. A., assistant engineer, Connecticut Light & Power Co., Berlin, Conn.
Christ, G. J., plant extension engineer, New York Telephone Co., Brooklyn, N. Y.
Donaldson, W. A., Jr., electrical engineer, Sargent & Lundy, Engineers, Chicago, Ill.
Gossman, H. G., T&D standards engineer, Dayton Power & Light Co., Dayton, Ohio
Hornfeck, L. W., electrical engineer, 711 Penn Ave. Bldg., Pittsburgh, Pa.
Hurson, F. J., president, Commonwealth Electric Co., Inc., Washington, Ind.
Kelsey, E. S., communication studies engineer, Northern Electric Co., Ltd., Montreal, Que., Canada
Kirk, I. M., trunk engineer, Illinois Bell Telephone Co., Chicago, Ill.
Kunstadt, G. H., senior engineer, Raytheon Mfg. Co., Newton, Mass.
Marshall, F. C., senior electrical engineer, McColpin-Christie Corp., Los Angeles, Calif.
McNeill, R. E., partner, McNeill & Baldwin, Consulting Engineers, 1025 St. Paul St., Baltimore, Md.
McStay, F. W., apparatus engineer, Line Material Co., Minneapolis, Minn.
Newman, J. J., electrical engineer, public works office, 12th Naval District, San Bruno, Calif.
O'Connor, J. P., electrical engineer, Naval Research Laboratory, Washington, D. C.
Pearsall, G. H., Jr., distribution engineer, Consolidated Edison Co. of New York, Inc., New York, N. Y.
Peterson, S. E., assistant project engineer, Omaha Public Power District, Omaha, Nebr.
Pilgrim, J. A., engineer, Southern Services, Inc., Birmingham, Ala.
Robbins, R. B., plant engineer, Bethlehem Steel Co., Beaumont, Tex.
Ryan, J. C., application engineer, Westinghouse Electric Corp., New Orleans, La.
Salko, J. R., designer, Pennsylvania Transformer Co., Canonsburg, Pa.
Sanger, K. E., principal assistant engineer, Franklin J. Leerburger, consulting engineer, 250 E. 43d St., New York, N. Y.
Shean, F. A., Jr., application engineer, General Electric Co., Schenectady, N. Y.
Shumar, R. F., electrical engineer, Dow Chemical Co., Midland, Mich.
Stewart, C. A., senior engineer, Kansas Power & Light Co., Manhattan, Kans.
Sweetland, R. N., technical engineer, International Business Machines Corp., Poughkeepsie, N. Y.
Truman, F. L., electrical engineer, Black & Veatch, Kansas City, Mo.
Tynes, R. A., partner, Tynes & Loftin, Engineers, 250 Korber Bldg., Albuquerque, N. Mex.
Wayland, J. R., division meter superintendent, Southwestern Public Service Co., Plainview, Tex.
Wilson, H. O., electrical engineer, The Shawinigan Engineering Co., Ltd., Montreal, Que., Canada

33 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership, in the grade of Fellow and Member, have been received from the following candidates, and any member objecting to election should supply a signed statement to the Secretary before March 25, 1954, or May 25, 1954, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Ahrendt, W. R., The Ahrendt Instrument Co., College Park, Md.
Hafstad, L. R., U.S. Atomic Energy Commission, Washington, D.C.
Hardy, H. C., Associated Electrical Industries (India) Ltd., Calcutta, India
Jarrett, V., Western Electric Co. Inc., Chicago, Ill.
Szorc, L. W., Moloney Electric Co., St. Louis, Mo.
Toulon, P. M. G., Westinghouse Laboratory, East Pittsburgh, Pa.
Walton, E. H., The United Illuminating Co., New Haven, Conn.

7 to grade of Member

OF CURRENT INTEREST

Life-Line-A Motor Is Product of Long-Range Research Development Program

The new Life-Line-A integral-horsepower induction motor is the product of long-range programs of research and development as announced by F. C. Rushing, manager, motor engineering, Westinghouse Electric Corporation. Some of the new features are results of more than 10 years of development, and none stem from short-term, concentrated development programs. All conform to the new suggested National Electrical Manufacturers Association standards which call for smaller motors per horsepower. In addition, there are to be found improvements in insulation, a more efficient and better protected bearing, an improved ventilating system, and quieter operation.

The four major types of insulation are the insulation for wire to be used in the stator and rotor windings; the insulation between stator coils and in the coil slot; the insulation of the finished stator or dip insulation; and the insulation of the motor leads.

The new Bondar wire insulation used in the stator and rotor windings is an especially developed synthetic resin insulation. It has been in the test, research, and development stages for 15 years in Westinghouse and has been tested on thousands of motors. In this time, it has shown itself to have a life over three times that of other motor wire insulations now in use because of its higher thermal endurance. This greatly extended life is achieved at no sacrifice in dielectric strength.

Slot insulation on the new Westinghouse motor is a combination of the extremely strong Mylar* polyester film and rag paper. In tension tests, this combination of the same dimensions used in the motor will take up to 360 pounds before failing. It occupies less space than the previously used varnished cambric and paper, has a dielectric strength four times that of varnished cloth, and a heat endurance of three to four times more. Greater resistance to mechanical damage is achieved also by cuffing the ends of the slots, thus insuring proper centering of the core.

The Bondite dip insulation on the Life-Line-A motor stators is a clear phenolic-alkyd thermosetting-type varnish. It is fortified with water-repelling silicone and has, at elevated temperatures, a life of 170 per cent of the previously used varnish. After being applied to the stator in multiple dips and bakes, it dries uniformly to form a tough, flexible bond with excellent resistance to oils, solvents, alkalis, acids, and moisture. And finally, it has an extremely high dielectric strength.

The motor leads in the new motors are smaller in diameter and more flexible. Life of the insulation is twice that of previously used cable or lead insulation at normal operating temperatures, and it is rated at 75 C compared to 60 C for previous cable insulation. Lacquered glass braid covering on the cable or leads not only provides greater heat resistance but also higher strength.

These new insulation features are extremely important factors in long motor life and high reliability.

The ventilation openings on the Life-Line-A motor are comparatively small and are located normal to the shaft axis in one quadrant of the periphery of the end-brackets. This position makes the motor much better protected from drippings. The end-brackets can be rotated to any position to make the motor completely dripproof.

* DuPont Trademark.

Totally enclosed fan-cooled motor running for weeks in clouds of highly abrasive dust to test effectiveness of bearing by-pass, blower, and other special features

Future Meetings of Other Societies

Air Conditioning and Refrigeration Institute. Educational Conference on Air Conditioning and Commercial Refrigeration. March 11–13, 1954, Long Beach, Calif.

American Chemical Society. 125th National Meeting. March 24–April 1, 1954, Kansas City, Mo.

American Management Association. General Management Conference. March 9–12, 1954, Fairmont Hotel, San Francisco, Calif.

American Power Conference. 16th Annual Meeting. March 24–26, 1954, Sherman Hotel, Chicago, Ill.

American Society of Tool Engineers. 10th Biennial Industrial Exposition. April 26–30, 1954, Philadelphia Convention Center, Philadelphia, Pa.

Conference for Protective Relay Engineers. 7th Annual Conference. April 26–28, 1954, Agricultural and Mechanical College of Texas, College Station, Tex.

Conference on Instrumentation in Water, Sewage, and Industrial Waste Treatment. April 22, 1954, Manhattan College, New York, N. Y.

Edison Electric Institute. 20th Annual Sales Conference. April 5–8, 1954, Edgewater Beach Hotel, Chicago, Ill.

Institute of Physics. Conference on the Physics of Particle Size Analysis. April 6–9, 1954, University of Nottingham, Nottingham, England

Institute of Radio Engineers. National Convention. March 22-25, 1954, Waldorf-Astoria Hotel and Kingsbridge Armory, New York, N. Y.

Institute of Radio Engineers—Polytechnic Institute of Brooklyn. Symposium on Information Networks. April 12–14, 1954, Engineering Societies Building, New York, N. Y.

Instrumentation Conference. 2d Annual Conference. April 8–9, 1954, Louisiana Polytechnic Institute, Ruston, La.

Metal Powder Association. 10th Annual Meeting and Metal Powder Show. April 26–28, 1954, Drake Hotel, Chicago, Ill.

National Association of Corrosion Engineers. 10th Annual Conference and Exhibition. March 15–19, 1954, Kansas City, Mo.

National Electrical Manufacturers Association. March 8–11, 1954, Edgewater Beach Hotel, Chicago, Ill.

Northwest Electric Light and Power Association. Engineering and Operations Sections. April 15–17, 1954, Olympic Hotel, Seattle, Wash.

Rice Institute Exposition of Engineering, Science, and Arts. 14th Biennial Review. April 2–3, 1954, Rice Institute, Houston, Tex.

Royal Netherlands International Industries Fair. 62d International Trade Fair. March 30–April 8, 1954, Utrecht, Netherlands

Society of Automotive Engineers. National Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display. April 12–15, 1954, Hotel Statler, New York, N. Y.

Society of Automotive Engineers. National Passenger Car, Body, and Materials Meeting. March 2–4, 1954, Hotel Statler, Detroit, Mich.

Society of Automotive Engineers. National Production Meeting and Forum. March 29–31, 1954, The Drake, Chicago, Ill.

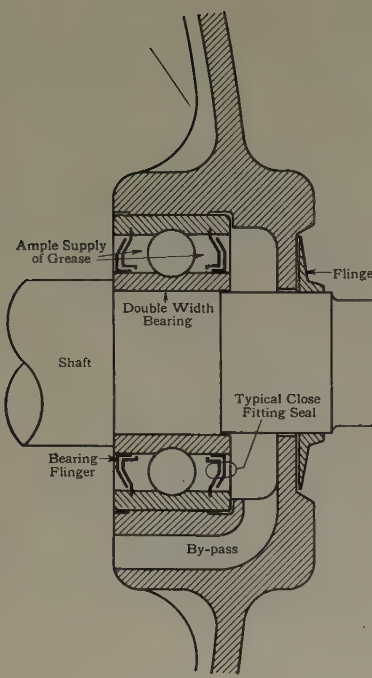
Society of the Plastics Industry (Canada). 12th Annual Conference. April 5–6, 1954, Mount Royal Hotel, Montreal, Que., Canada

Society of Women Engineers. National Convention. March 5–7, 1954, Washington, D. C.

Southeastern Electric Exchange. 21st Annual Conference. March 22–24, 1954, Boca Raton Hotel, Boca Raton, Fla.

Stanford Research Institute—U. S. Air Force. Symposium on the Automatic Production of Electronic Equipment. April 19–20, 1954, Fairmont Hotel, San Francisco, Calif.

The American Society of Mechanical Engineers. International Meeting. March 10–12, 1954, Del Prado Hotel, Mexico, D. F., Mexico.

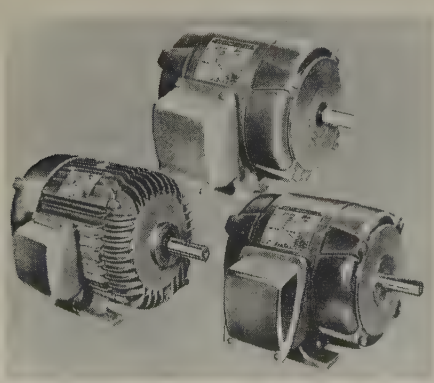


Cross section of new bearing for enclosed motor shows the by-pass and external flinger which stop foreign particles from passing through the bearing

Dripproof motors can be used now for any application where a totally enclosed motor is not required and are suitable for either indoor or outdoor application.

The effective volume of electrical sheet steel in the new motor is about 15 per cent less than in the old. The weight of copper is practically the same. The steel reduction has been made through proper selection of high-grade silicon steel, reducing losses for a given flux density by as much as 20 per cent. There has been no reduction in permeability in making this decrease. Square punchings with rounded corners were used on previous motors. The new line uses circular punchings with a smaller frame to make maximum use of available space. Stray losses have been kept at a minimum by design, processing, and treatment of rotor surfaces.

These motors have been designed with particular attention to torque characteristics. They have good running torque characteristics at all speeds. Even though the motors are smaller, there has been no sacrifice in electrical characteristics.



The Life Line-A motors include the dripproof motor on the right, the totally enclosed fan-cooled on the left, and the enclosed nonventilated in the middle

Bearings have a 4-way seal—two on each side of the motor bearing. The inner seal is stationary and is attached to the outer bearing race while the outer seal rotates and is attached to the inner bearing race. The function of the rotating outer seal, or flinger, is to throw off any foreign elements trying to enter the bearing. This combination of seal and flinger has been proved effective by severe laboratory tests and by selected difficult field installations.

Lubrication of raceways and retainers where sliding friction exists and protection of highly finished surfaces against corrosion are two of the most important functions of the grease. To be satisfactory, a grease must have an extremely long life and must have a number of independent properties, such as oxidation stability and high melting point. These properties must be maintained over a wide range of combinations of temperature, speed, and bearing load.

There is a particular bearing problem in enclosed motors. Such motors are subjected to severe service conditions in contaminated atmospheres, both abrasive and gaseous. Exhaustive tests indicate that under certain conditions an air pressure differential exists across a bearing, meaning that the motor will breathe through the bearing, and if there are gases, moisture, or dirt particles in the atmosphere, these tend to enter the motor through the bearing. They usually are filtered out and retained by the bearing grease. This tends to lead to breakdown of the grease and, ultimately, bearing failure.

A combination bearing by-pass and a neoprene external flinger on the new Westinghouse enclosed motor eliminates this difficulty. The by-pass equalizes the pressure on both sides of the bearing thereby stopping the contaminated air from passing through the bearing. The external flinger acts as an effective dust thrower for particles which try to enter the by-pass.

The totally enclosed fan-cooled motor has been made extra suitable for use in contaminated atmospheres by other mechanical improvements. The blower on the fan-cooled motor is a molded glass plastic with high corrosion resistance. The frame for the totally enclosed fan-cooled motor has fins to provide maximum area for heat dissipation and to allow greater ease in cleaning. All the exposed parts of both totally enclosed nonventilated and totally enclosed fan-cooled motors are corrosion resistant.

The frame—both stator frame and end-brackets—are made of cast iron. The relative merits of steel and cast iron were thoroughly analyzed for user needs, design flexibility, and ease of manufacture. Because of recent developments in casting techniques, the over-all balance favored cast iron.

The dripproof enclosure has been improved to such an extent that it is now virtually splashproof and the splashproof enclosure has been eliminated.

One of the big mechanical accomplishments in the motor is the reduction in noise. In the new motor, stator coils are so positioned that the required electrical characteristics are produced with minimum of accompanying harmonics that produce noise. Manufacturing procedures assuring more uniform air gaps have been adopted. Mechanical parts free of resonance at existing exciting frequencies, and ball bearings with improved ball and raceway finishes and carefully controlled radial clearances all help reduce noise. Tests show that for an open 1,800-rpm motor in the lower horsepower range, the sound level of the older motors ranged from 55 to 60 db, while that of the new version lies between 50 and 55 db, or the noise level in the average office.

Radio Astronomy Conference Discusses Radiations in Radio Range From Space

A 3-day conference on radio astronomy, jointly sponsored by the National Science Foundation, the Carnegie Institution of Washington, and the California Institute of Technology, was held in Washington, D. C., at the Carnegie Institution of Washington, January 4–6, 1954. The conference was called for the purpose of discussing the current status of research in this country and abroad, the nature of the problems facing radio astronomers, and profitable directions for future work in the relatively new field of radio astronomy. Investigations of invisible radiations in the radio range coming from the sky became an especially promising new method of attacking astronomical problems after ultrasensitive short-wave receivers were developed during World War II.

The conference opened with a presentation of work in Great Britain and Australia on the discovery and analysis of sources of radio signals from space. In addition to the radiation from our own Milky Way system, so-called "discrete sources" have been found. B. Y. Mills of Australia and R. Hanbury-Brown of Manchester, England, described measures of the sizes and energy distributions in these sources. Some are abnormal clouds of hot gas in our own system, others are very distant extragalactic nebulae. The radiation found is far too intense to be explained on any theory so far advanced. In addition to the already known brighter galaxies, evidence was presented for the existence of radiation from a great cloud of galaxies stretching over a region of 10 million light years.

Up to the present time most discoveries of radio sources have referred to relatively faint and in many cases unidentified objects; but now, for the first time, F. T. Haddock, C. H. Mayer, and R. M. Sloanaker of the U. S. Naval Research Laboratory, discovered in December 1953 radio waves emanating from the gases from the better-known bright nebulae of the Milky Way, among them the famous nebula in the sword of Orion.

Dr. E. G. Bowen, chief of the Radio Physics Laboratory in Australia, reported on the

discovery by Paul Wild of fast-moving particles in the sun's atmosphere at the time of a major flare-up in the sun's radiation. Such particles were known to be ejected with speeds of the order of 500 to 1,000 miles per second; the new evidence indicates, in addition, blasts of particles with speeds as high as 60,000 miles per second.

Various speakers at the conference presented gathering evidence to confirm the long-suspected variations of brightness over the sun's surface, which indicate that at certain radio wavelengths the sun appears brighter at the rim than at the center. In addition, the observations reported confirm that our sun at long radio wavelengths appears at least twice as large as the visible sun because of its very hot gaseous envelope, the corona. The outermost envelope of the sun proves to be much larger than expected; clouds of hot gas were traced out to 10 million miles when they eclipsed a distant radio source, according to observations at Cambridge, England, reported by F. G. Smith.

The discrete sources of radio signals from space have had a very interesting application in the study of the upper atmosphere of the earth. At a height of about 400 miles clouds of ions and electrons exist which reflect and scatter radio waves. F. G. Smith of Cambridge and C. G. Little of Manchester reported on the observation of the rapid motion of these clouds of charged particles. The radio sources twinkle as the clouds pass in front of them, and from the rate of twinkling they have found that winds blow with speeds of from 10 to 1,000 mph at this level.

These observations of radio sources involve the use of enormous aerials. At Manchester a parabolic antenna 218 feet in diameter is used. In Cambridge an aerial with approximately 60,000 square feet can be directed at various parts of the sky to obtain high resolution. The Naval Research Laboratory in Washington, D. C., has a precision 50-foot parabola which can be directed to all parts of the sky. For observations of the outer layers of the sun, the apparatus has been carried to Egypt and other places for observations of solar eclipses at radio frequencies.

According to Dr. C. R. Burrows of Cornell University it has been determined that the short intense bursts of radiation from the sun at meter wavelengths are circularly polarized. This work is of astrophysical interest because it gives a new method for obtaining information about the corona.

Dr. Helen Dodson of the McMath-Hulbert Observatory presented information about a different kind of radio burst and her correlation of such radio bursts with solar flares. Solar flares are familiar because of their effects on the ionosphere and on radio communication; there exists almost exact equivalence between the occurrence of chromospheric flares and radio bursts measured at 10-cm wavelengths.

Dr. Rudolph L. Minkowski of the Mount Wilson and Palomar Observatories reported on the astronomical observations of the identified discrete radio sources. In every case these have proved to be objects of unusual appearance. One type of source originates as the result of a collision between two galaxies. In such a case the gas in one system collides with the gas in the other system with enormous velocities and the collision is presumably the source of the radio noise. In another case a phenomenon resembling a jet stream is found to be emitted from the nucleus of one of the galaxies. Whereas the colliding galaxies are at a distance of the order of 200 million light years from the sun, the gas clouds of our own galaxy that sometimes produce radio sources are only a few thousand light years from our sun. By observations of the internal motions in the gas clouds, Dr. Minkowski has found that those with the larger velocities emit the stronger radio noise.

Dr. Jesse L. Greenstein of the Mount Wilson and Palomar Observatories gave computations of the r-f emission of hot gases such as are found in the gaseous nebulae of the Milky Way. These have been observed recently, at the Naval Research Laboratory, for the first time on radio waves and will be observable with high precision as work proceeds at shorter wavelengths. The enormous excess radiation that has been observed in some of the discrete sources cannot arise from the heat content of the gases, but must come from a process which converts a large fraction of the total collision energy of the colliding gas clouds into r-f noise.

Dr. Fred Hoyle of St. John's College, Cambridge, England, gave the results of a new theory of the emission of radio waves from very-high-energy electrons which might occur when gases collide at high speeds. Hoyle computed that electrons would be accelerated by magnetic fields to near the velocity of light and then lose their energy by emitting radio noise.

Dr. F. G. Smith, also of Cambridge, surveyed the status of knowledge concerning the radio radiation from our own and other galaxies. He stressed that further advances in our knowledge of the radio universe would depend largely on the type of equipment that will become available in the future. The larger apertures of future telescopes and further developments in the construction of receiving equipment more than anything else will determine advances in this field.

One of the four portable reflector aerials used in the interferometer at the Cavendish Laboratory, Cambridge University, Cambridge, England

The conference closed with discussions that centered primarily around the problems of instrumentation in connection with the detection of the 21-cm line from interstellar hydrogen and the strength of special line emissions that also might be found in the astronomical r-f range.

Russian Translated Into English by Electronic Computer in a Few Seconds

Russian was translated into English by an electronic data-processing machine for the first time recently.

Brief statements about politics, law, mathematics, chemistry, metallurgy, communications, and military affairs were submitted in Russian by linguists of the Georgetown University Institute of Languages and Linguistics to the *701* computer of the International Business Machines (IBM) Corporation, and the giant computer, within a few seconds, turned the sentences into easily readable English.

More than 60 Russian sentences were given to the computer altogether. All were translated smoothly in a demonstration performed jointly by Georgetown and IBM as a phase of IBM's endowed research in computation.

"The potential value of this experiment for the national interest in defense or in peace is readily seen," Professor Leon Dostert, Georgetown language scholar who originated the practical approach to the idea of electronic translation, declared to the group of scientists and U. S. government officials who witnessed the demonstration.

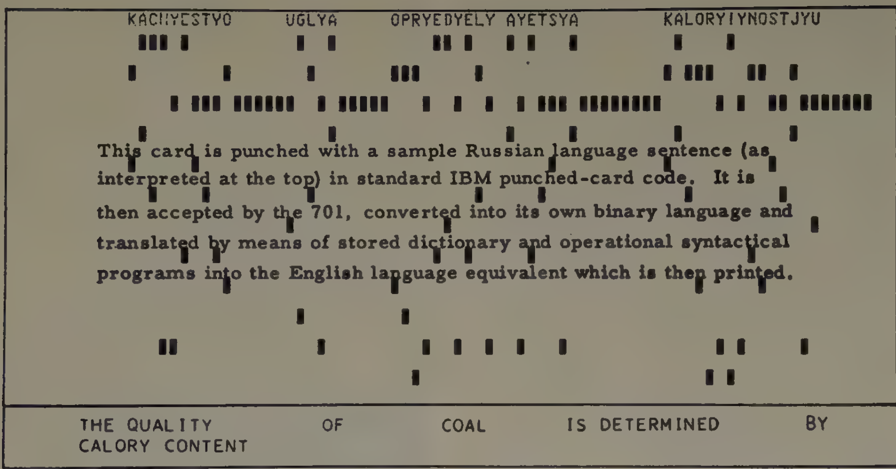
"Those in charge of this experiment now consider it to be definitely established that meaning conversion through electronic language translation is feasible."

Although he emphasized that it is not yet possible "to insert a Russian book at one end and come out with an English book at the other," Dr. Dostert predicted that "5, perhaps 3, years hence, interlingual meaning conversion by electronic process in important functional areas of several languages may well be an accomplished fact."

What the electronic translators have done actually is to create an entirely new electronic language. They have taken normal words and attached to them tags or signs which give each word a precision it does not usually possess. These signs actually denote rules of grammar and meaning. Although only six rules were used in the demonstration, the six were enough to cover all the words in all the sentences the *701* was asked to translate.

The IBM computer could translate only because these rule-tags were hitched onto normal words, it only can perform tasks in obedience to detailed instructions prepared by human minds.

The six rule-tags were the solution. Those particular six were chosen because they have



Specimen punched card and below a strip with translation, printed within a few seconds

a broader effect on language translation than any other rules studied by the Georgetown linguists. Dr. Dostort estimates that it may take as many as 100 rule-tags to translate scientific and technical literature in general. But, no matter how large the number becomes the six will remain basic.

The six rules govern transposition of words where that is required in order to make sense, choice of meanings where a word has more than one interpretation, omission of words that are not required for a correct translation, and insertion of words that are required to make sense.

After the six rules were formulated as the foundation of electronic translation, the linguists tried them out on themselves. First they wrote out sentences in Russian. Then they wrote out instructions as to how the rule-signs could be placed in the Russian-English glossary to lead to the proper English translation. After that, they gave the Russian sentences and the instructions to government officials and others in Washington who knew nothing about Russian or electronic computers. The officials followed the instructions and came up with the right translations.

The first step in preparing IBM's computer to repeat this human performance of a mechanical task was to write electronically, in plus and minus charges on a magnetic drum surface, 250 Russian words and their equivalents in English. Wherever a Russian word had more than one meaning, each meaning was given a rule-sign. This set of electronic words then constituted the dictionary to which the computer could refer.

The second step in preparing the *701* to translate was to store the detailed instructions—exactly like those the people in Washington had followed, except that these were written in electric charges on the faces of cathode-ray tubes in the *701*'s electrostatic memory.

All that remained to be done after that was to give the computer the Russian words to translate. The computer responded at the rate of one full sentence every 6 or 7 seconds.

What the *701* actually did, in executing the Russian-English translation, was to create within itself a working model of another computer specially designed to handle logic instead of mathematics.

Human Blood Cells Counted Accurately by TV Camera Used as "Eye" of Computer

The television camera has been turned into the eye of a simple and ingenious computer to count microscopic particles such as blood cells, bacterial cultures, or grains of photographic emulsion. The system, known in its laboratory stage as the Sanguinometer and shown on the cover, was developed by a team of electronics engineers at the David Sarnoff Research Center of the Radio Corporation of America (RCA) in Princeton, N. J., working in close co-operation with the Sloan-Kettering Institute, research unit of the Memorial Center for Cancer and Allied Diseases, in New York, N. Y.

The equipment was devised to provide a simple, rapid, and accurate mass method of taking blood counts to detect the first signs of radiation sickness among persons in the target area of an atomic bomb. A blood count is an important indicator in many diseases and in those circumstances where anemia may be a complication, such as overexposure to radiation which may occur during atomic attacks.

In addition to this possible emergency use, its application is foreseen in hospitals and research centers to perform almost instantaneously and with a minimum of error a process that long has been a laborious, time-consuming, and often unprecise manual operation in laboratory work.

The Sanguinometer is essentially a closed-circuit industrial television system combined with an optical microscope and a novel computer that has the ability to make a count of particles in a given field by means of a unique electronic circuit developed by L. E. Flory and W. S. Pike, of the technical staff, RCA Laboratories Division. The television camera, substituting for the eye of the observer at the eyepiece of the microscope, feeds the information it "sees" to both the computer and a monitor viewing screen, used in the developmental version to help in focusing and illuminating the microscopic specimen.

The development of the Sanguinometer was carried out together with Dr. Leon Hellman, of the Sloan-Kettering Institute, who encouraged the use of the television "eye" as the basis of a rapid counting system and worked closely with the RCA scientists both in adapting the controls into a simple form suitable for clinical use and in conducting tests of the instrument on samples of human blood.

In operation, the camera tube of the Sanguinometer, scanning the specimen under the microscope, sends out video pulses as the scanning beam strikes the images of the particles to be counted, and the pulses in turn actuate an electronic counter. As in all television processes the beam scans its field of vision from side to side, progressing downward in a series of parallel lines. The lines are so close together that in a normal microscopic magnification each particle to be counted interrupts several lines as the scanning beam moves across the field, and consequently produces several pulses in the output of the television system. This means that large particles will interrupt more lines and produce more pulses individually than will small ones, and that the counter would be unable to distinguish between a large number of small particles or a small number of large ones unless compensation is made for their size.

This obstacle was overcome by an ingenious diameter compensation circuit that is able to determine the average size of the particles by taking account of a direct relationship between the average time duration of the pulses and the diameter of the particles. This indicates the number of video pulses created by each particle, a figure that is electronically fed to the counter where it divides the total number of pulses to give an automatic reading of the actual number of particles.

The entire process, as performed by the latest laboratory model of the Sanguinometer, is both simple and far more rapid than any manual count. Once the slide is prepared and put under the microscope, the operator manipulates a single control knob on the counting meter until an electric eye tube on the meter case is closed. This indicates that compensation has been made for the average diameter of the particles to be counted. It is then necessary for the operator only to read the meter to determine the number of particles in the field of the microscope.

During laboratory tests employing microscopic blood specimens, an operator with the Sanguinometer was able to make several counts of red cells in various regions of the specimen and average the results before a technician operating without the equipment could complete a single count.

This test, incidentally, has pointed up one great advantage of the device in its ability to take account of nonuniform distribution of particles. Readings taken by the Sanguinometer at various points over

the surface of a given specimen were found to vary by as much as 20 per cent, since blood cells or other particles generally are distributed unevenly in any given sample. The computer, however, easily can take a number of readings and permit an average to be arrived at rapidly, a process which would be prohibitively laborious and time consuming in manual counting.

The Sanguinometer has indicated in tests that it is capable of handling with only a small margin of error a count of many varieties of microscopic particles as long as the particles within any one specimen are nearly uniform in size. It is not suitable for counting particles whose sizes and shapes usually vary widely in a single specimen.

To guarantee the continued accuracy of the computer when it is used steadily, its developers have included a simple calibration technique. To check operation of the computer, it is necessary only to prepare a permanent calibration slide which can be used occasionally to determine whether the particle count rate remains constant.

Application of the system generally is believed to depend more upon economic factors than upon technical possibilities, and with the increasing availability of low-cost closed-circuit industrial television chains, its wide use in medical and industrial research appears likely, its developers said.

Direct Conversion of Nuclear Energy to Usable Electricity Achieved

A new method which makes it possible to convert atomic energy directly and simply into small but usable quantities of electric energy sufficient to operate a transistor, was announced January 27, 1954, by Brigadier General David Sarnoff, chairman of the board of the Radio Corporation of America (RCA).

In his office at Radio City, General Sarnoff displayed an RCA atomic battery which operated the transistor to produce audible tones.

The new type of battery consists of a radioactive source to which is coupled a wafer of semiconducting crystal (germanium or silicon). An impurity material has been alloyed into the crystal to form a junction. The junction is similar electrically to those used in a junction transistor, but is considerably larger, with an area of 1/20th of a square inch.

Strontium 90, one of the most abundant of the materials resulting from the fission of uranium in a reactor, is a highly active source of beta particles and is one of the long-lived beta-emitting substances. Its half-life is roughly 20 years.

In the battery, 1/300th of a cubic centimeter (a quantity that would fill a cube 1/16th of an inch on a side) of radioactive strontium is spread in a thin layer against the junction wafer. The layer of strontium bombards the semiconducting crystal wafer with several billion electrons per second. As the electrons penetrate the wafer they release many more electrons, an average of 200,000 for each bombarding electron.

Previous radioactive generators simply captured the high-speed electrons as they came from the radioactive source with the result that they provided approximately one electron for each bombarding electron. In the present experimental atomic battery, each high-speed electron releases in the crystal, on the average, 200,000 low-speed electrons. These released electrons flow across the wafer's junction producing a voltage which can be applied to an electronic circuit and cause a current to flow. The electron action within the crystal wafer is known as the electron-voltaic effect, a phenomenon of solid-state physics which has not been put to any practical use.

When connected to the transistor oscillator circuit, the battery's 1/5-volt potential provides a current of 5 microamperes, an output of approximately one millionth of a watt. The best efficiency of energy conversion so far obtained exceeds 1 per cent, i.e., the ratio of useful electric power developed by the battery is at least 1/100th the energy of the beta particles as they leave the radioactive source. The greater part of the original energy is lost as heat in the crystal wafer. As present techniques are refined, an efficiency of 10 per cent appears to be a reasonable goal for such devices.

Greater power can be achieved by increasing the present 50-millicurie quantity of strontium 90 or by placing a number of such units in a single container.

Although in theory, virtually any radioactive material could be the source of an atomic battery, strontium 90 was chosen to activate the RCA device because of its high-energy beta radiation, its relatively long life, its low shielding requirements, and its availability in experimental quantities from the U. S. Atomic Energy Commission.

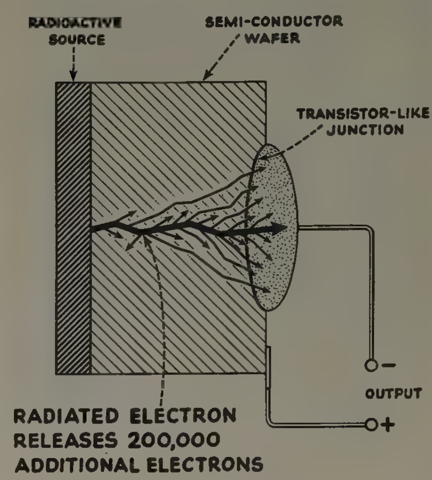
Strontium 90 is not now obtainable in completely purified form, i.e., other fission products have not been entirely separated from it. Since some of the unwanted radioactive materials are emitters of gamma radiation, shielding is necessary in the laboratory device.

However, strontium 90 in purified form emits only beta particles which, for the quantities that would be used in a small atomic battery, does not raise problems of shielding.

Strontium 90 costs about 50¢ for 1/1,000th of a curie today. A wide demand for the material in atomic batteries and other applications would warrant quantity processing of the material. This, it has been estimated, might bring its price down as low as 0.002¢ for a 1/1,000th of a curie.

An aspect of atomic batteries that has yet to be determined accurately is the extent of the effect of the beta radiation on the crystal wafer. It is known that the crystal structure

EXPERIMENTAL RCA ATOMIC BATTERY



Simplified cross-section view of experimental RCA atomic battery. Each electron captured by the semiconductor wafer releases on the average 200,000 more electrons which build up voltage as they flow across the junction

Magnified model of the two basic elements of atomic battery. Cylinder (at right) has thin coating of radioactive material on its face which is placed next to transistor-like wafer

Dr. Ernest G. Linder (left) and Paul Rappaport, RCA scientists, with experimental RCA atomic battery

of many substances is gradually damaged by bombarding electrons. Further research is in progress to minimize these effects so as to make them negligible for the structures used in the atomic battery.

EMC and SMC Report Progress on Reserve Manpower Policies

The recent release by the Office of Defense Mobilization (ODM) of the report of the Committee on Manpower Resources for National Security indicates a fundamental change in the thinking of ODM and the Executive Department regarding the structure of our military reserve forces. This change reflects the thinking which has been contained in various Engineering Manpower Commission (EMC) and Scientific Manpower Commission (SMC) policy statements and recommendations on this subject.

The report of this committee, under the chairmanship of Lawrence Appley, is a comprehensive review of manpower resources and their capabilities for full mobilization. The points of greatest importance to those who are interested in the industrial as well as the military mobilization base are recommendations for reorganization of the military reserve into two forces:

The first reserve force, of a strength level to be determined by the President in consultation with the National Security Council, would be available for instant recall as units or individuals when needed. This reserve would be screened occupationally and physically and maintained in a high state of training for military service. This would provide a reserve military manpower immediately available without serious impairment of the supporting industrial activities.

The remainder of the reserve force would be placed in a selectively recallable reserve. The committee suggested that there are several means by which such selective call to active duty could be achieved. However, achievement of the degree of selectivity required in a future emergency could best be obtained, said the committee, by the operation of a simple procurement system for the call-up of all military manpower except members of the immediately recallable reserve. The Appley Committee felt that the Selective Service System appears best suited to perform this procurement function.

The importance attached to this report by the President is indicated by his deferment of the question of Universal Military Training until the problem of the reserve structure is well on the way to solution. The President has set April 1, 1954, as the target date for final recommendations on the future structure of a realistic reserve.

EMC and SMC have done a great deal of work on this subject, and they feel that the mobilization agencies of the government are becoming aware of the true scope and complexity of reserve manpower problems.

Competition Opened for MIT Management Fellowships

Competition for fellowships to the 1954-1955 Executive Development Program, covering one year of advanced study in industrial management at the Massachusetts Institute of Technology (MIT), has been opened by Dean E. P. Brooks of the MIT School of Industrial Management.

Fellowships for the 1954-1955 program, Dean Brooks said, will be given to young executives who are nominated by their employers on the basis of "marked promise of growth into major executive responsibilities."

The nation-wide competition will close on March 5, 1954. Applications and further information are now available from Professor Gerald B. Tallman, director of the program.

The year's study in the Executive Development Program is devoted to fundamental problems of business enterprise. "Despite their years of successful activity in special phases of industry, most young executives lack a familiarity with the wide range of essential business functions foreign to their own experience," Professor Tallman explains. "They need, too," he adds, "a sense of the over-all relationships between seemingly unrelated activities, as in such areas as labor relations, the interrelationship of government and industry, domestic and international economy, and sociological development.

"We are concerned," Professor Tallman emphasizes, "with the development in future leaders of a broad understanding not only of the several functions within their companies but also of the role of their companies in the nation's industrial economy and social structure.

"Experience with the Executive Development Program since it was started over 20 years ago has indicated that MIT can best serve industry by giving an unusual opportunity to a limited number of able men. Because the program extends over a full year, it allows a breadth of coverage and degree of penetration into fundamentals which are impossible in a shorter space of time."

Participation in the Executive Development Program is limited to between 30 and 36 recipients of Sloan Fellowships. Nomination by an employer is a prerequisite, since employers co-operate in the program by sponsoring these men and by providing successful candidates with a year's leave of absence and financial aid. Fellows are drawn from both large and small companies in various types of industry.

Candidates normally must be between the ages of 30 and 35 and they should have at least 5 to 10 years of industrial experience, with part of this experience in a managerial capacity. Fellowship winners will be selected on a competitive basis by MIT after consideration of the applicants' records and references and after consultation with their employers.

Awards include cash grants ranging upward from $1,000. Members of the 1954-1955 Executive Development Program will be in residence at the institute in Cambridge, Mass., for 12 months beginning in June 1954. Each is expected to move his family to Boston for the year.

The introductory summer term which will begin in June 1954 will provide for Executive Development Program members a preliminary study of management and economic problems which will be for most of them a first exposure to organized examination of these fields.

In the following fall and spring terms the work at the school will be built around a series of seminars and courses dealing with management operations; economics and science; industrial relations and public policy; administrative policy; American foreign policy, law, and industrial history; human relations; and philosophical aspects of managerial theory.

The educational resources of the School of Industrial Management are supplemented by those of the MIT Department of Economics and Social Science. In addition, a distinguished group of industrial, government, and labor leaders meet with the Sloan Fellows or receive them on field trips covering many different types of industrial operations.

The Fellows as a group spend about 2 weeks in plant visits. During a third week in the New York area members of the program meet with a substantial number of top business leaders; and a week in Washington provides them with first-hand experience with the points of view of important government agency heads and policy makers.

Complete information on the Executive Development Program and application blanks for Sloan Fellowships may be obtained from the Director of the Executive Development Program, MIT School of Industrial Management, 50 Memorial Drive, Cambridge 39, Mass.

25-Billion-Volt Accelerator to Be Built at Brookhaven

The U. S. Atomic Energy Commission has approved design and construction at Brookhaven National Laboratory of an ultrahigh-energy particle accelerator for nuclear research. The new machine, an alternating gradient synchrotron, will be designed to produce beams of protons of energies ranging up to 25 billion electron volts.

The alternating gradient synchrotron will use a series of alternate strongly converging and diverging magnetic fields to confine a proton beam in a tube of relatively small

cross section. This focusing effect allows the production of high-energy beams with smaller electromagnets and related equipment than would be possible otherwise.

The cost of design and construction of the new accelerator is estimated at $20,000,000. Design work will start at Brookhaven in the near future and it is expected that the machine can be completed in 5 to 6 years. Once in operation, it will be available to scientists wishing to collaborate in Brookhaven research programs or to carry out independent programs.

As a means of producing nuclear reactions under controlled conditions on a laboratory scale, particle accelerators have played an important role in the advancement of nuclear science and contributed much of the fundamental scientific information used in the design of nuclear reactors. The energy of the particle beams produced by accelerators bears a direct relationship to the nuclear phenomena that can be studied. As higher energy levels have been attained in laboratory machines, new subnuclear particles have been discovered and new nuclear phenomena observed.

The most powerful accelerator now in operation is the Brookhaven Cosmotron, which has accelerated protons to energies of 2.3 billion electron volts. The Bevatron, under construction at the University of California Radiation Laboratory at Berkeley, is expected to accelerate particles into the 5 to 7 billion electron volt range. By providing particles with energies as high as 25 billion electron volts, the Brookhaven alternating gradient synchrotron is expected to contribute important new knowledge of the fundamental nature of matter.

Experimental Car Tests Possible Use of Gas Turbine Engine

Scientific advances in the past few decades particularly in metallurgy and aerodynamics have contributed to rapid progress in gas turbine engine development. The 370-hp Whirlfire Turbo-Power engine (*GT-302*) is an effort by General Motors Research Laboratories Division to determine whether this type of power is feasible for automotive use.

The Whirlfire Turbo-Power unit is designed for rear installation in the Firebird XP-21 experimental car. The engine is divided into two mechanically independent parts, the gasifier section and the power section, connected by a flexible duct. The gasifier section consists of the following elements: 1. a single-stage centrifugal compressor of approximately $3^1/_2$-to-1 pressure ratio; 2. twin combustion chambers (burners); 3. a single-stage axial flow turbine; and 4. engine accessories. The power section consists of: 1. a single-stage axial flow power turbine; 2. transmission; 3. final drive unit (rear axle gears).

The gasifier's function is to provide a source of hot compressed gas. Energy is extracted from this gas and delivered to the rear wheels by the power section.

The power flow of the Whirlfire engine may be compared to a conventional engine with torque converter transmission. The gasifier section replaces the engine and torque converter pump, while the power section replaces the torque converter turbine, transmission, and rear axle gears.

The gasifier-power section combination operates by way of a gas coupling rather than a fluid or oil coupling that is used between the torque converter pump and turbine of an automatic drive or torque converter in a conventional automobile.

The Whirlfire gasifier closely resembles a small jet engine. The curved vane compressor rotor and the gasifier turbine wheel form the backbone of this section of the engine.

Air entering the engine is compressed to more than $3^1/_2$ times atmospheric pressure before it enters the engine's two combustion chambers or burners.

Kerosene is sprayed into the burners where combustion takes place continuously after a spark ignites the mixture for starting. The gas outlet temperature is approximately 1,500 F.

The engine's starter mechanism is actuated by a 24-volt electric system and must "rev up" the compressor and gasifier turbine to 3,000 rpm before the engine starts. The Whirlfire idles at 8,000 rpm.

The hot gas enters the gasifier nozzle ring where it is accelerated and directed tangentially into the curved blades or "buckets" attached to the rim of the gasifier turbine wheel. Extraction of power necessary to drive the gasifier compressor results in a reduction of both temperature and pressure of the gas.

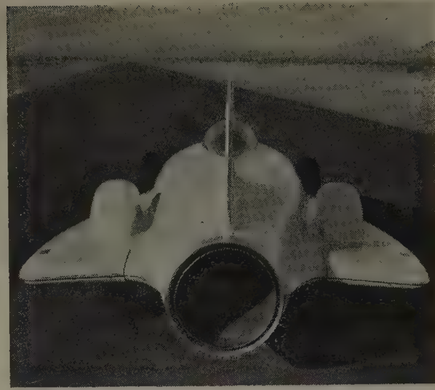
Thus, the compression, combustion, power, and exhaust strokes that occur intermittently in cylinders of a conventional engine are continuous and separate processes in the gas turbine engine.

The exhaust gas from the gasifier section next passes through the power turbine. Here the hot gas drives the power turbine wheel of the power section. The power section consists of the power turbine, transmission, and final drive gears.

Transmission gears permit the Firebird's driver manually to select the drive range, low range, or reverse. This is virtually the same as the system used in the automatic drive selector of a conventional car.

The engine unit develops 370 hp at maximum output with the gasifier operating at 26,000 rpm and the power turbine turning at 13,300 rpm.

The gasifier section weighs only 340 pounds and the power section is 435 pounds, more than half of which is attributed to the transmission case and gears. Total weight is



Rear view of XP-21 Firebird shows aerodynamic body shape with tail fin and swept-back delta wings. On the trailing edges of the wings are brake flaps that supplement the car's wheel braking system

775 pounds, giving the power "package" a weight-to-power ratio of about 2 pounds per horsepower. This is about one-third the weight-to-power ratio of a conventional passenger car power plant and drive train.

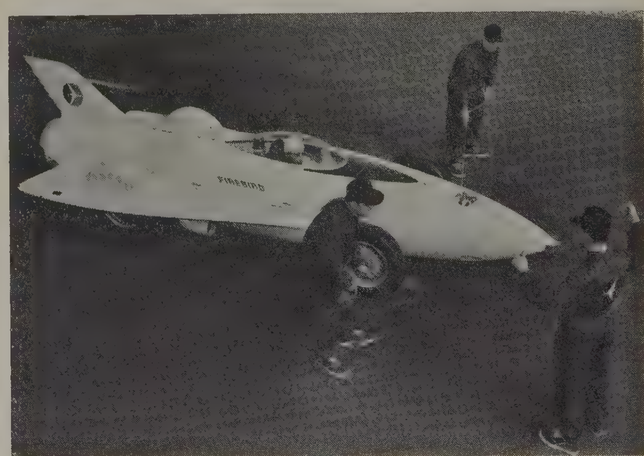
The power section delivers maximum torque to the rear wheels when the vehicle is standing still. Thus, the engine has built-in torque converter characteristics, making it unnecessary to shift gears during normal driving.

The conventional radiator and cooling system essential to a piston engine is eliminated with the gas turbine engine. An ignition system is required only for starting and is not used while driving. A safety device automatically shuts down the engine if one of the two burners fails to fire or start.

Turbine buckets for both the gasifier and power turbines were made from a new super-high-temperature alloy designated as *GMR-235*. They were precision cast by the so-called lost wax investment process. The engine's nozzle diaphrams also were cast from a new alloy, *GMR-426W*. These parts were cast in shell molds.

The car has an independent front suspension. Engineers describe it as a double wishbone type with torsion bar spring. The torsion bar also is a member of the lower wishbone, while the upper wishbone is formed by the shock absorber arms.

The steering knuckles are connected to the two wishbones by ball joints, eliminating the



Test driver signals for start of test run of experimental gas turbine automobile

conventional kingpin. A roll stabilizer bar is included in the assembly to increase roll stiffness of the front suspension.

Rear suspension is a deDion design with a tubular axle connecting the rear wheels. The final drive unit, as part of the transmission, is mounted on the chassis and remains stationary. Twin universal joints give the rear wheel drive shafts flexibility.

The rest of the rear suspension includes two single leaf springs which are attached to a pivoted "walking beam" paralleling the rear cross member of the car's frame. It is designed to reduce roll stiffness of the rear suspension. The springs are mounted above the axle to produce a high roll center.

The Firebird's main braking system is hydraulically controlled. All shoes are arranged in a forward direction and there is one wheel cylinder per shoe.

The heavy duty brakes were designed with the drums mounted on the outside of the wheel bearings for good cooling and accessibility. The drums are composite castings in which a finned aluminum hub was cast around an alloy cast iron friction surface.

The car has two independent braking systems for front and rear brakes with independent master cylinders. A balancing piston connects the two systems and equalizes the pressure when both systems function normally.

If one system becomes inoperative, the balance piston will lock and close off the intact system so that the remaining brakes will continue to function.

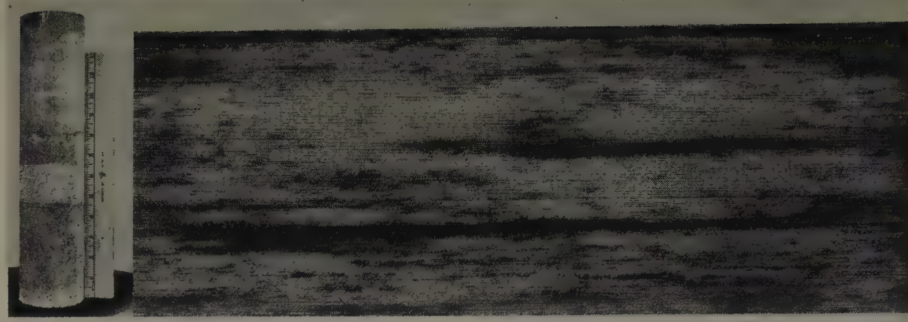
Ultrasonic Technique Developed for Nondestructive Testing

Reed Research, Inc., recently has completed development of an ultrasonic technique for the nondestructive testing of certain nonmetallic solids. The work was sponsored by the U.S. Navy Bureau of Ordnance.

Prototype test equipment, incorporating ultrasonic absorption techniques and automatic scanning, has been built which will produce high-contrast records of simulated flaws, or mechanical defects, which were imperceptible in X-ray photographs of the same sample.

In this new system a pair of barium titanate transducers are arranged to transmit and receive acoustic energy (continuous wave transmission at 383 kc) along radii of the cyclindrical test sample which is revolved about its longitudinal axis at 100 rpm. The transducers simultaneously traverse the length of the cylinder at a rate of approximately 0.1 inch per revolution of the cylinder, producing a helical scan the full length of the sample. This entire assembly is submersed in water for good acoustic coupling. The scanning mechanism is coupled through gears to a cylindrical recording drum having the same angular velocity as the test sample.

The output from the receiver transducer is fed through appropriate electronic circuitry to a tungsten stylus held in contact with electrosensitive paper (Teledeltos) mounted on the recording drum. As in facsimile recording, the stylus traverses the length of the rotating drum, leaving a trace whose intensity (dot size) corresponds to the level of intensity at the receiver.



Acoustigraph of concrete cylinder shows narrow horizontal bands due to layers of sand and wood chips introduced during casting

The resulting record, or Acoustigraph, may be interpreted in the same manner as a positive radiograph which might be obtained by passing an X-ray source along the center perforation of a stationary cylinder wrapped with photographic film. Dark areas in both types of records represent regions of decreased transmission through the material being inspected. However, the Acoustigraph can be obtained at any convenient scale. In the present equipment, a sample 14 inches long is represented by 3 inches on the record, a full revolution by 9 inches.

It can be seen that the new system combines the major advantages of X-ray and ultrasonic testing methods as identified by the following distinctive features:

(*a*). Immediate availability of test results (no processing) in an easily interpreted form (graphic presentation).

(*b*). Inherently high sensitivity to internal mechanical flaws (voids, cracks, porous regions, poor bonds, density variations).

(*c*). Easily controlled contrast and differential sensitivity in the final record (nonlinear electronic amplification).

(*d*). Freedom from high-voltage and radiation hazards.

(*e*). Low initial and operating costs (recording paper costs approximately 3 cents per sheet).

Although the present equipment was designed to fulfill a particular need, it is apparent that the combination of basic principles employed are applicable to a wide variety of inspection problems. As an illustration, cylindrical samples of wood, Bakelite, rubber, graphite, and concrete were fabricated and tested with the equipment. Obviously, other simple geometrics such as rectangular blocks, flat plates, and thin sheets could be handled by a scanning mechanism employing motions of translation rather than rotation.

Where details of the flaw (shape, size, and location) are of secondary interest relative to its presence, the system could be extended to accomodate much more complicated shapes by comparing patterns in the test record with those in a standard record representing a flawless piece.

In all nondestructive testing it becomes necessary to establish acceptance-rejection criteria, which generally are based on correlation between some relatively indirect indication of flaws in a group of specimens with the actual operational performance (usually these will be destructive of the same group).

For many problems, the Acoustigraph will provide a cheaper and much more sensitive indication than X rays. Furthermore, it will provide a permanent record in a form which is much easier to interpret and correlate than conventional ultrasonic displays.

Enrollments Now Accepted for Oak Ridge Reactor School

The Oak Ridge School of Reactor Technology is now accepting applications for the 1954–55 session, according to an announcement by Dr. Fred C. VonderLage, director of the school. Applications for the class beginning in September must be submitted for review by the Committee on Admissions not later than March 15, 1954.

Approximately 80 students will be selected by the Atomic Energy Commission's (AEC) Admissions Committee to attend the session that begins in September 1954. Students eligible for the 50-week graduate course must hold a bachelors degree or higher in chemistry, engineering, metallurgy, physics, or engineering-physics. The school is a part of Oak Ridge National Laboratory which is operated by Union Carbide and Carbon Corporation for the AEC. It is one of the largest laboratories in the world, and is concerned with research and development in nearly all phases of nuclear science and technology.

The curriculum is geared to the advanced student in science. The scope of the school's curriculum is indicated by its over-all objective: "The Oak Ridge School of Reactor Technology was organized to educate selected students in reactor technology and in the application of basic sciences, applied sciences, and modern engineering techniques to the design and development of reactor systems and their components."

The faculty includes many distinguished technicians and researchers. In addition, staff members of the Oak Ridge National Laboratory instruct small student sections and conduct lecture classes.

Many of the leading industries, seeing the possibilities for peacetime application of reactor technology, are sponsoring students. Forty-eight members of the present class are sponsored students who remain on the payroll of their respective companies during the training period. The remaining members of the class, recent college graduates,

are paid a monthly salary by Union Carbide and Carbon Corporation. There is no tuition charge for the 50-week training session.

The curriculum will include such subjects as the following, as they apply to reactors: analysis and mathematics, chemistry and chemical technology, engineering, nuclear physics, and experimental physics. The coming term will be the fifth formal session.

Further information and application forms may be obtained from the Oak Ridge School of Reactor Technology, P. O. Box P, Oak Ridge, Tenn.

Radar Altimeter Gives Reading of Plane's Height Above Earth

A radar altimeter has been developed that keeps a pilot informed at all times of his height above the surface of the earth. It was developed by Raytheon Manufacturing Company, Waltham, Mass., under contract with the U.S. Navy's Bureau of Aeronautics. The device is a new and improved radar altimeter that already has proved its ability to give instant, direct, and reliable altitude information. Representing a 10-year advancement in the use of radar for measuring altitude, the equipment has been accepted by the Bureau of Aeronautics and currently is being studied by the Air Force.

The new radar altimeter works by sending speed-of-light signals down to the surface of the earth. The signals bounce back in millionths of a second, and the time it takes them to return is measured electronically and converted automatically to the instrument panel, where it reads altitude in feet. The pilot has before him at all times an instant, accurate answer to the question, "How high am I?"

The era of all-weather flying is brought a step nearer with this latest engineering triumph, for it functions reliably from a few inches off the ground to the limits of its range of operation. The ability of the instrument to give a true and instantaneous height reading is considered as a tremendous help in military flying. Equipped with this new altimeter, pilots will be able to maneuver aircraft with greater safety. Raytheon's altimeter can be set so that a warning light will indicate to the pilot when he has gone below the desired altitude.

An important advantage of the new device is the instantaneous altitude indication it affords, without "instrument lag." This is a vital factor in view of the speeds attained by today's jet planes.

Errors in the new Raytheon altimeter are almost impossible. If the device picks up a false or misleading signal, the indicator needle is automatically "masked out," or hidden from view temporarily. When the system has found a true reading again, the needle becomes visible. This ingenious detail rules out, for example, errors that may be caused by a faulty receiving tube, a weak transmitted signal, or radio interference.

The total weight of the new altimeter is approximately 30 pounds. The transmitting and receiving antennas are mounted flush beneath the wing, an important factor in high-speed flight. The entire system is designed for maximum convenience of maintenance and ease of calibration.

The new altimeter has been tested at Raytheon's flight-test facility at Bedford, Mass., and has met official acceptance tests at the Naval Air Development Center, Johnsville, Pa. and the Naval Air Test Center at Patuxent, Md.

New Television Receiver Shows Two Programs Simultaneously

A new type of television receiver which shows two programs on one screen while permitting two audiences to view their choices simultaneously has been introduced by Allen B. Du Mont Laboratories, Inc. The receiver is known as the "Du Mont Duoscopic."

The Duoscopic receiver can tune in any two television programs from any stations within range. Translated into home entertainment, it means the husband may choose to view one program while his wife watches another.

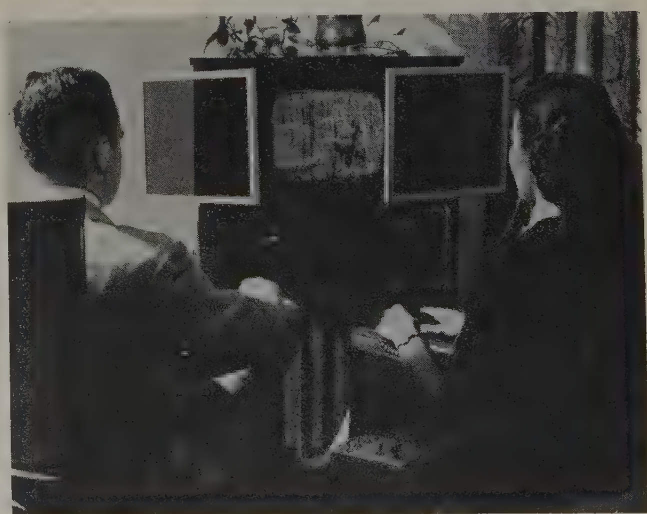
Using polaroid glasses or panels, a particular program at one moment can be seen and then, by merely reversing the glasses, a different telecast. With personalized ear pieces and convenient remote-control audio units, either of the two programs can be heard.

It was pointed out that groups of family viewers could select any programs desired and yet, when an individual wished, he could switch independently to another channel. The remote control unit of the "Solo Sound System" made possible audio synchronization with the channel change. Audio volume could be lowered or raised to accommodate the listener's preference.

The sturdy, comfortable polaroid glasses have a role in Duoscopic viewing. With them, television viewers may "switch" from one channel to the other on the screen and then back to the first program simply by reversing the glasses.

The audio control unit has six switches and two small knobs. When a switch is flicked by the viewer, he receives the audio signal of his choice. A turn of the knob at the televiewer's elbow and the sound volume can be lowered or increased. In fact, one very easily could watch one television program and listen to the audio content of a second.

Du Mont engineers pointed out that home viewers can "tune out" one of the two television pictures on the screen. In this contingency, the Du Mont Duoscopic functions in the same manner as today's conventional receiver. Engineers also said that with the dual sound system, the audio portion can be heard with or without earpieces. Yet, the sound systems have been engineered in Du Mont Laboratories to permit viewers to eliminate the audio version from one or both of the speakers.



Wife and husband are watching and listening to two different programs at the same time on the same screen

Nuclear Reactor to Be Built by Pennsylvania State University

The U.S. Atomic Energy Commission (AEC) has approved the allocation of fissionable material as fuel for a nuclear reactor to be built by Pennsylvania State University.

The low-power "swimming-pool"-type reactor will be operated for nuclear research and for the training of students. It is the second privately owned reactor for which the AEC has authorized the use of nuclear fuel. The first, built by the Consolidated University of North Carolina, began operation September 5, 1953.

The Pennsylvania State University reactor will be constructed and housed on the university campus for an estimated $250,000 to $300,000. The cost of construction and operation will be borne by the university, without financial assistance from the AEC. The reactor will operate at a power level of 100 kw. It will be cooled and moderated with ordinary water, and will use enriched uranium fuel. The fuel elements will be suspended in a pool of water sufficiently deep to serve as a shield against the radiation produced by the reactor.

A similar "swimming pool" facility, the Bulk Shielding Test Reactor, has been in operation at Oak Ridge National Laboratory since 1952. Experience with the Bulk Shielding Test Reactor has demonstrated that this type of reactor is inexpensive, safe to operate, and easy to maintain.

Actual transfer of fissionable material required for the reactor will occur after

the AEC has given final approval to health, safety, and security aspects of the completed reactor and the plan for its operation.

The reactor project is under the technical direction of Dr. William M. Breazeale, professor of electrical engineering at the university. Dr. Breazeale formerly was on the staff of the AEC's Oak Ridge National Laboratory, and was project engineer for the Bulk Shielding Test Reactor at Oak Ridge.

The School of Engineering at the university will administer the reactor project, but the reactor also will be utilized for research of interest to the School of Mineral Industries, the School of Chemistry, and the School of Agriculture.

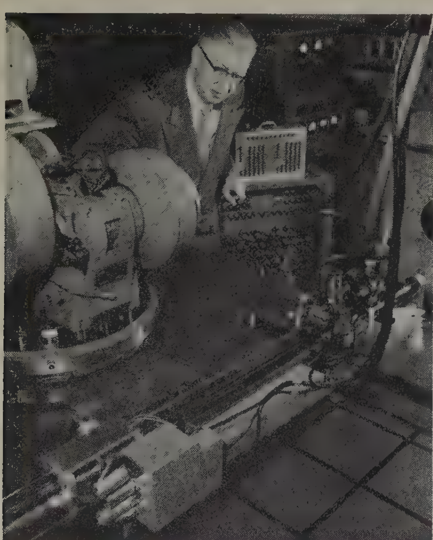
Automatic Punch Press With Electronic Brain Developed

An automatic punch press with an electronic brain has been developed by General Electric scientists and its techniques are being adapted to electronic equipment fabrication under a U. S. Signal Corps contract.

Directions are fed to the punch press by an electronic digital computer. The computer reads a perforated card which has information on size, number, and location of the holes to be punched. The punch press automatically positions the materials to be perforated and performs its punching operations within an accuracy of a few thousandths of an inch.

Walter Hausz, a manager in the laboratories department of the company's Electronics Division, said the automatic punch press is a by-product of development work being done by the scientists under contract with the Signal Corps.

This contract calls for the development of a system of automatic machinery to assemble and test electronic circuit subassemblies for various military electronic equipment, Hausz explained.



Automatic punch press is controlled by an electronic brain. The machine has been described as a forerunner to an automatic assembly machine

The scientist described the automatic punch press as the forerunner to an assembly machine to be used in the automatic assembly system being developed for the Signal Corps. The Signal Corps support of this automatic factory program is based on the recognized need for vastly expanded electronic production to meet the anticipated demand in case of emergencies.

He said the standard turret-type punch press was made automatic primarily as a proving ground for techniques and component elements to be embodied in the assembly machine.

Hausz also explained that a version of the punch press could be used to punch holes in printed wiring boards in the preparation of these boards for the placement of various components by the automatic assembly system.

The punch press will be removed from the laboratory in the near future, Hausz said, and will be placed in a factory for further development and experimental use to determine if it is a practical means for increasing worker productivity in other areas.

He pointed out that the techniques employed to make the punch press perform automatically well may be applied to a number of other industrial operations. Hausz said these include drilling, riveting, stapling, electrical testing, and many others.

According to Hausz, the automatic assembly system being developed for the Signal Corps will place from 10 to 50 standard components, such as resistors and subminiature tubes, on printed wiring boards at a rate of 30 per minute. This rate can be increased on any one production line by using additional placement machines. The final system also will provide for preparation and testing of components, for transporting them to the assembly machine, and for soldering and testing the completed subassemblies.

The entire system, scheduled for completion in 1955, will be supervised electronically by means of perforated cards, which will contain the various programming information.

Hausz emphasized that the automatic assembly system is not intended to produce completed products such as radar or television sets, but will produce printed circuit subassemblies for electronic equipment. The subassemblies will be manually combined into complete products, until other machines may be devised to perform the task.

Hausz said the automatic component assembly system would make its greatest contribution "in improved automation of the small quantity production typical of many military products and specialized commercial lines such as radio and television transmitters and studio equipment, and microwave communication equipment."

He explained that while much effort has been applied to the automatic production of electronic equipment to be made by the hundreds or thousands, efforts to increase productivity of job shops have been lacking.

The automatic component assembly system General Electric is developing for the Signal Corps is being designed for the greatest possible flexibility. A change can be made in the subassembly the system is producing merely by punching new directions on a new program card. No retooling or operator training time would be required, Hausz said.

Electronic Noise Absorber Traps Low-Frequency Noise

An electronic noise-absorbing device has been developed by the Radio Corporation of America (RCA) which promises quiet for the future.

H. F. Olson and E. G. May, of RCA's Princeton, N. J., laboratories, have developed the device to the stage of reducing volume of low-frequency sounds before they reach the human ear. The scientists also visualize quiet rooms in a boiler factory and noiseless airplanes, automobiles, and air-conditioning systems.

In its present state, however, the noise absorber is too primitive for industrial or home use. Eventually the scientists visualize a reduction, through the use of transistors, in the device's present typewriter-like size. Then, workers in noisy places may be able to carry the devices near their heads to protect their ears. The noise absorber could be placed at the exhaust of an engine or near a big machine and pick off the noise.

Mr. Olson has explained the device as follows:

Sound is actually the movement of the molecules of air in wavelike motions. The undulations of the air strike the human eardrum and the brain interprets the pitch, or frequency of the sound.

The noise absorber consists of a microphone and loudspeaker. As the microphone picks up the first suggestion of any movement of air corresponding to a sound, it sends an electric signal to the loudspeaker. The loudspeaker, in turn, sends out a sound—a movement of air—that nullifies the original air movements. The result is a reduction in sound.

As described by the scientists, the experimental device can reduce the sound coming toward the microphone to 1/16th of its intensity at a distance of 10 inches from the microphone and to 1/4 of the intensity 24 inches away.

X-Ray Diffraction School Will Be Held at Philips Plant

The 16th session of the semiannual X-Ray Diffraction School for registrants who find it convenient to visit New York City will be held at the plant of North American Philips Company, Inc., 750 South Fulton Avenue, Mount Vernon, N. Y., during the week of April 19–23, 1954.

Registration for the week-long school will be limited to 125 for the first 4 days and to 150 on Friday, this day being devoted to actual application problems when guest speakers discuss details on methods currently in use in research and industrial laboratories and plants.

Monday through Thursday, the sessions involve extensive classroom and laboratory work wherein opportunity is provided for participants to discuss their own problems

and to become familiar with actual use of all types of equipment.

Basic subjects to be covered by prominent educators and scientists will include X-ray diffraction, diffractometry, and spectrography. There also will be discussions on new high- and low-temperature camera techniques, electron microscopy, and electron diffraction.

It is recommended that those who wish to attend the coming April meetings make reservations at the earliest possible date. There is no registration fee.

Philips held its first West Coast X-Ray Diffraction School in August 1953, for registrants who find it convenient to visit San Francisco, Calif. This western school will be repeated annually and registrations for the summer sessions may be sent in now.

Air Force Scientists Study "Jet Stream" in Atmosphere

The "Jet Stream," an immense air current that ranges over the northern hemisphere at altitudes between 30,000 and 40,000 feet, and sometimes reaches speeds of 300 mph, is being studied intensively for the first time by Air Force Cambridge (Mass.) Research Center scientists. Since definite evidence of the jet stream was established in 1947, the Air Force and commercial air lines have been interested in finding more about this horizontal escalator in the sky that can boost a plane along with almost incredible swiftness.

Now the Air Research and Development Command, with co-operation from the Strategic Air Command, has established two points for research flights into the jet stream at MacDill Field and Patrick Air Force Base, both in Florida. A *B-47* jet bomber is used at MacDill Field, near Tampa, while a *B-29* bomber is stationed at Patrick Air Force Base, on Florida's east coast.

"Project Jet Stream" is being conducted under the immediate supervision of scientists from the Geophysics Research Directorate of the Air Force Cambridge Research Center.

The most intensive work on the project is scheduled for the 3 months of January, February, and March, when the colder weather brings more temperature variations at heights above Florida and other regions, and causes an increase in the velocity of the jet stream.

In December Lieutenant Colonel Henry Mead, who is the senior Air Force officer assigned to the project, recorded a high of 126 knots (approximately 138 miles per hour) for the jet stream over Florida. It is expected that the stream will reach speeds of more than 200 mph before March.

Each of the planes involved in the project is equipped with special instruments to measure winds, temperatures, humidity, and turbulence. In addition, observers use tape recordings to make verbal descriptions while they are in flight. Recordings and observations are made every few miles.

Now in its early stages, "Project Jet Stream" is expected to furnish much more information to the scientists by the time all flights have been completed and data has been compiled and studied. Present Air Force plans call for continuation of the project throughout 1954 and until February or March 1955.

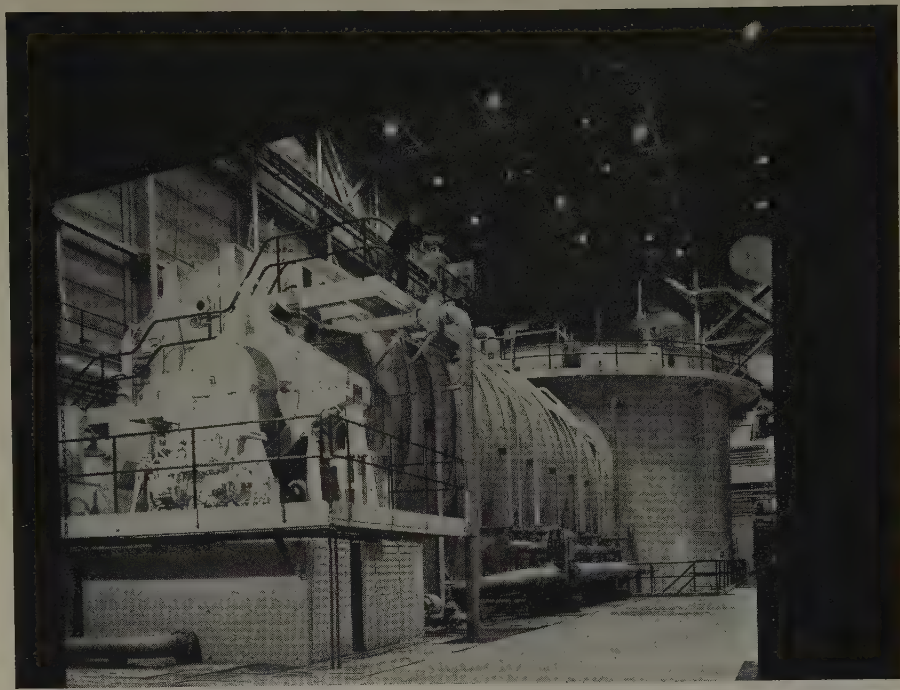
Air Force scientists agree that the jet stream is capable of speeds up to 300 mph which will be of considerable aid to both military and commercial planes that can take advantage of this super tailwind in traveling from west to east. The scientists also say that there can be danger should an aircraft accidentally enter the stream in the opposite direction. Unless he has a very powerful plane, there is a possibility that the pilot will find his craft standing still, or even moving backward, gripped by the gigantic power of the jet stream.

An unofficial report from Japan, which the Air Force Cambridge Research Center scientists are inclined to feel may be exaggerated, place the speed of one jet stream at 445 mph.

Other findings show that the jet stream is about 400 miles wide, with a "core" which contains the highest velocity of air currents. The stream does not follow a straight path, but meanders in snakelike fashion throughout the atmosphere, changing position slowly, and maintaining a generally eastward trend.

There can be more than one jet stream in the atmosphere at the same time. A map of these super air currents in December showed one jet stream moving in a northeast direction up the eastern coast of the United States, while another came down from the northwest, through Canada and the Great Lakes Region. At times, two jet streams will converge and merge into one.

Indoor Submarine Has First Atomic Engine



Inside the hull of this indoor submarine is the first atomic engine ever to produce substantial quantities of power. Designed and built by Westinghouse Electric Corporation in co-operation with the Atomic Energy Commission, this nuclear power plant (Mark I) was built for long-range testing and operation and is a prototype of the actual engine (Mark II) which will drive the recently launched atomic submarine, USS Nautilus. This view of the first atomic engine, looking through the largest door of the main assembly building, shows the aft end of the hull and the large "sea tank" which surrounds the reactor compartment

Edison Electric Institute Issues Electric Output Index

The Edison Electric Institute (EEI) released for the first time on January 13, 1954, a seasonally adjusted index of weekly electric output of the total utility industry. The index value for each week will be issued on the Wednesday following, as part of the present EEI weekly report.

Electric output is defined by the EEI as the electric energy available for distribution from the output of all plants contributing to the public supply. This comprises the total electrical utility industry which includes investor-owned companies, co-operatives, and government-owned utilities but it excludes industrial, railroad, and other plants which generate electricity for private use.

The new index is based on the 3-year average output for the years 1947, 1948, and 1949. This is the same base period to which the recently announced Federal Reserve revised index of industrial production and the American Iron and Steel

Institute's new index of steel output have been keyed among others. The new index eventually will afford direct comparisons of the long-term growth trends as well as the shorter-term "pulse beats" of the electrical utility industry with those of the over-all national economy and its principal segments—not previously possible. The EEI cautions that their index embraces more than just industrial or manufacturing activity. More than half of total electric energy produced is for residential, commercial, agricultural, transportation, and other uses.

Technically speaking this new index is the result of adjusting weekly reported output values for normal seasonal and holiday variations only and expressing the adjusted values in per cent of the 1947–49 average. Hence, the index reflects long-term growth of the industry, and the effects of changing business conditions, major work stoppages, and abnormal or nonseasonal weather.

A pamphlet describing this newest of indexes is in process of completion and will be available upon request to the Edison Electric Institute, 420 Lexington Avenue, New York 17, N. Y.

$1,378,000 Program Announced for Engineering Center

A $1,378,000 building and development program for the construction of a new downtown Engineering Center has been announced by the Cleveland Engineering Society.

Plans for the project, which will be completed as the society prepares for its 75th anniversary, have been outlined at a number of special meetings for the membership and the area's industrial leaders.

To be known as the Cleveland Engineering Center, the 2-story structure will be of contemporary design and will provide facilities aimed at making it the focal point of all engineering activities in northeastern Ohio.

Some 36,000 square feet of space will be provided in the new center. It will have an auditorium seating 950 people and dining rooms equipped to serve 400 people. Preliminary architectural sketches show unusual designs for meeting and conference rooms and classrooms, administrative offices, and industrial exhibit space. Escalators will operate between the main lobby and the auditorium, while freight elevators will bring industrial equipment to the auditorium stage level.

Pausing beneath the architect's sketch of the new Engineering Center to be constructed in Cleveland are A. T. Colwell, vice-president and director, Thompson Products, Inc.; Sam Littlejohn, commercial vice-president, General Electric Company; and Elmer Lindseth, president, Cleveland Electric Illuminating Company

EMC Announces 1954 Objectives in Co-operation With SMC

The Engineering Manpower Commission (EMC) of Engineers Joint Council has announced that Dr. T. H. Chilton (American Institute of Chemical Engineers) will continue to serve as chairman of EMC during 1954; M. M. Boring (AIEE) will be vice-chairman during 1954. T. A. Marshall, Jr., will continue as EMC executive secretary.

M. T. Carpenter, administrative director, Standard Oil Company of Indiana, has been elected president of the Scientific Manpower Commission (SMC), succeeding H. A. Meyerhoff. Dr. Meyerhoff will continue to direct SMC activities under the title of executive director. J. S. Nichols of Yale University will be SMC vice-president during 1954, and Dael Wolfle of the National Research Council has accepted the responsibilities of secretary-treasurer.

As during 1953, the basic objectives of the EMC for 1954 will be as follows:

1. To co-operate with industry, with government, and with private agencies to secure better utilization of engineers.
2. To co-operate with responsible Federal, state, educational, and industrial agencies concerned with engineering manpower in developing (*a*) accurate statistics and forecasts of supply and demand, (*b*) determination of the distribution of the supply of new engineering graduates, (*c*) improvement in quality and quantity of new engineering graduates through better qualification and interest in high school students.
3. To maintain a continuing surveillance of the national scene with respect to engineering manpower so as to provide a clearing house of information for, and a channel of communication between, the profession, industry, government, and others on this subject.
4. To secure even closer co-ordination of engineering and scientific manpower activities.
5. To secure and maintain an adequate flow of students into the engineering colleges through the promotion of interest in and knowledge of the work of the engineering profession.

In carrying out this program, EMC will maintain close contact with industry, with the engineering colleges, and with those agencies and others whose activities are concerned with the manpower policies and problems affecting the engineering profession.

Polyethylene-Insulated Cable Links Europe and South America

The longest single polyethylene-insulated cable ever laid now links Europe with South America across the South Atlantic. Because of the low dielectric constant of polyethylene, a smaller cable is possible which, in turn, leads to a reduction in over-all weight. Subsequently, the cost of the cable is reduced by more than one-third.

Four European cable manufacturers in England, France, Germany, and Italy produced more than 1,750 miles of this cable insulated for the most part with polyethylene supplied by Bakelite Company, a Division of Union Carbide and Carbon Corporation. After several months of satisfactory test operation, this telegraph link between the Old and New Worlds has been put into service as a commercial cable by Italcable, Rome, Italy.

Replacing a section of cable lost during World War II, the new link restores direct telegraph service between Italy and South America. The new cable stretches 1,758 nautical miles across the South Atlantic from Recife, Brazil, to St. Vincent in the Cape Verde Islands, off the west coast of Africa. The deep-sea portion of the cable—98 per cent of its total length—lies at depths well over 13,800 feet and attains 19,800 feet at one point, more than $3^1/_2$ miles down. In addition to polyethylene's low dielectric constant, its resistance to attack by salt water increases its importance for use in submarine communications cable of this type.

The cost of this cable with a core of gutta-percha (the material previously used for submarine cable insulation) would have been about 58 per cent higher than the cost of polyethylene core cable. A 25-per-cent saving in the amount of copper used for the conductors is due to the low dielectric constant of polyethylene, almost one-fifth lower than that of gutta-percha. The new cable required 13 per cent less steel wire to bear its own weight. Savings of more than 17 per cent in jute yarn for the core, and more than 7 per cent in outer-serving jute twist also were obtained by using polyethylene instead of gutta-percha for insulation.

The new cable has a traffic capacity of at least 300 letters per minute because of the excellent electrical properties of polyethylene. A maximum speed of 270 letters per minute was predicted for a similar cable insulated with gutta-percha on the basis of previous experience and electrical tests.

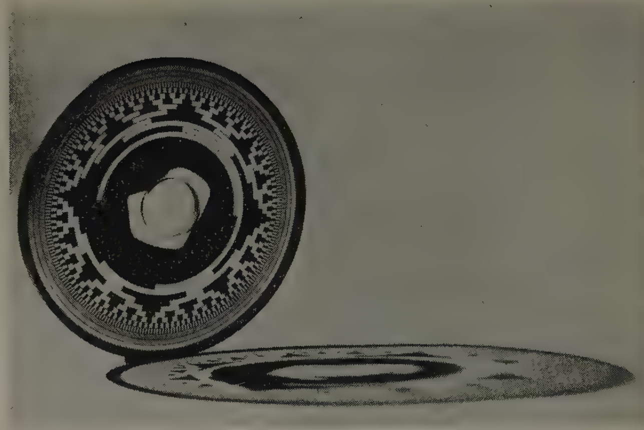
The new St. Vincent–Recife cable reinstates the major link in Italcable's transoceanic telegraph system, which was restored to their ownership in 1947. During World War II, all of their Atlantic and

Mediterranean cables had been cut and some diverted. A gap of approximately 2,000 nautical miles was left in the South Atlantic Ocean after the old 1925 Fernando de Noronha–St. Vincent cable was picked up and diverted to wartime use elsewhere. In 1952, cable to close the gap was ordered and produced by four European cable manufacturers in 8 months.

A cable-laying ship, the only one in the world capable of carrying more than 1,700 nautical miles of cable, picked up sections of the cable at Greenwich, England; Nordenham, Germany; Calais, France; and La Spezia, Italy. The actual laying operations in the South Atlantic were completed in little more than one month. When the terminal connections were made, the cable was thoroughly tested. The electrical characteristics of the new cable, it has been reported, are appreciably better than those specified.

An excellent dielectric, Bakelite polyethylene also has a unique combination of properties ideal for use with submarine cable including impermeability to moisture, light weight, chemical inertness, flexibility and resistance to abrasion and fatigue. It has been indicated also that Bakelite polyethylene compounds may be substantially resistant to attack by the toredo worm, which is a major problem in submarine cable maintenance.

Transducer Code Wheel Pattern Successfully Placed on Glass



Digital code wheel pattern with 13 concentric rings of alternating opaque and transparent sectors

The pattern for a digital code wheel, containing 13 concentric rings of alternating opaque and transparent sectors, has been successfully placed on glass by W. and L. E. Gurley, Troy, N. Y. The glass is $5^1/_2$ inches in diameter.

The number of sectors per zone increases by doubling to 2^{12}, or to 4,096 in the outer zone. Gurley was able to make the divisions in the outer ring less than 0.1 inch long and 0.004 inch wide.

Developed from a Bell Telephone Laboratories design, the code wheel will be used in a binary code transducer system. The system will supply data by rotational position of an instrument shaft to digital computers used in various military applications. Gurley's method of marking blanks by photographic methods has unlimited possibilities in reproduction of irregular patterns spaced at closely controlled regular intervals. This will supplant previously attempted methods with conventional dividing equipment.

The code wheel pattern on glass will make it possible to encode analogue data more accurately and simply than by other methods,

In actual use in encoding, one of the glass code wheels produced by Gurley is rigidly mounted on an instrument shaft, and light is passed through the wheel and a slit to phototransistors.

Computers used with the code wheel are based on a binary, rather than a decimal, system. In any position, the arrangement of opaque and clear sectors in the annular zones represents a specific binary number. It is possible to read a total of 8,192 number codes, which enable determination of accuracy of shaft position to approximately 2.5 minutes arc. As a prevention against ambiguity, the so-called "Gray code"—a special binary system—is employed.

Yale and Philosophical Society to Publish Franklin Papers

The launching of a 15-year project to gather, edit, and publish all of the known papers of Benjamin Franklin, whose 248th birthday anniversary was in January, was announced recently by the American Philosophical Society and Yale University, joint sponsors of the venture. The project has been made possible by a grant from *Life* magazine on behalf of Time Inc. The announcement was made by former Supreme Court Justice Owen J. Roberts, president of the 204-year old American Philosophical Society which was founded by Franklin himself, and A. Whitney Griswold, president of Yale University.

The edition will be the most inclusive ever published of the writings and papers of Franklin, scientist, philosopher, and statesman. It also will be one of the largest editorial ventures in the history of American book publishing.

To be administered by Yale and the Philosophical Society out of grants from *Life* magazine and the society, the venture will cost more than $600,000 over a 15-year period. The society already has spent $250,000 in the last 20 years assembling Franklin items for its own collection.

The editorial work, to be centered at Yale, will be under the editorship of Leonard W. Labaree, Farnam professor of history at Yale. The Yale University Press will publish the edition which is expected to run to 25 or 30 volumes.

Professor Labaree and his staff will make every effort to locate and print all of Franklin's writings, including official and personal correspondence, scientific articles, state papers, and contributions to contemporary journals, and as many as possible of the letters written to him by his wide circle of friends and acquaintances in Europe and America. An important item will be a fresh edition of Franklin's famous "Autobiography."

Albert Henry Smyth's 10-volume edition of "The Writings of Benjamin Franklin," published in 1907, is the most extensive edition to date but it contains only a relatively small part of all material now known to have been written by the noted Philadelphian. Much new material has come to light in the last 3 or 4 decades and will be incorporated into the new volumes.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Remote Control of Computer

To the Editor:

The November 1953 issue of *Electrical Engineering* (p. 1044) contains a news item regarding a recent demonstration by Burroughs Corporation of remote control of an electronic digital computer over a long telegraph circuit. This is spoken of as "probably the first attempt" at such operation. As a matter of historical interest, you may wish to call attention to a somewhat similar demonstration in 1940 in connection with the first digital computer developed by Bell Telephone Laboratories.

This computer, which was of relay type, was designed to perform arithmetical operations with complex numbers under direct control of a teletypewriter keyboard, and to print the problem and answer on the associated typewriter. The computer was used after the fashion of a desk calculator by several groups of computresses, each group having a teletypewriter at its work

location. The computer was in routine and substantially constant use for about 8 years, until superseded by a more modern programmed calculator.

Since the work locations were only a few hundred feet from the room in which the relay equipment was installed, multiconductor cables were used between them. However, during the summer meeting of the American Mathematical Society in 1940, a teletypewriter was installed at Dartmouth College, in Hanover, N. H., and connected to the calculating equipment in New York over a standard commercial 2-way telegraph circuit. Problems written on the keyboard were transmitted to New York; the computer registered the stated problem and retransmitted it to the typewriter in Hanover as confirmation; it also calculated and transmitted the answer. This setup was demonstrated by Dr. G. R. Stibitz in connection with a paper presented before the society on the opening day, and thereafter was kept in operation for inspection and use by the members. Since the computer transmitted digits of the answer as rapidly as they became available, and since most of the members were not rapid typists, part of the answer usually was received before the last digits of the problem had been punched up on the keyboard, which greatly delighted the users.

The computer art has advanced greatly since 1940. So far as can be judged from the brief news item, however, the requirements for transmitting input and output data were substantially the same in the Burroughs demonstration as in the Hanover–New York trial.

THORNTON C. FRY (F'50)
(Bell Telephone Laboratories, Inc., New York, N. Y.)

NEW BOOKS • • • • •

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

RESEARCH OPERATIONS IN INDUSTRY: Papers delivered at Third Annual Conference of Industrial Research, June 1952. Edited by David B. Hertz. King's Crown Press, Columbia University, New York, N. Y., 1953. 452 pages, 8³/₄ by 5³/₄ inches, bound. $8.50. Some 30 papers are broadly classified as follows: philosophy of industrial research; economics, costs, and budgeting; personnel in industrial research; planning of research programs; planning of facilities; methodology and design of experiment; operations research; communications and technical information services. Although mostly from the 1952 conference, a few selected papers from previous ones have been included to integrate the work.

TELEVISION RECEIVER DESIGN. Monograph 2: Flywheel Synchronization of Saw-Tooth Generators. By P. A. Neeteson. Philips' Technical Library, Eindhoven, Holland (distributed in United States by Elsevier Press Inc., 402 Lovett Boulevard, Houston 6, Tex.), 1953. 156 pages, 9¹/₄ by 6¹/₄ inches, bound. $4.50. Extending this series of monographs on electron tubes, the present book takes up the principles of saw-tooth generators, their circuits, and special tubes. Following a preliminary discussion of synchronization in general, the book provides a detailed analytical treatment of the "flywheel" system of synchronizing the scanning currents in television receivers with special emphasis on basic principles.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by AIEE members for a small handling charge. The library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

DATA AND CIRCUITS OF TELEVISION RECEIVING VALVES. By J. Jager. Philips Technical Library, Eindhoven, Holland, (available in U. S. from Elsevier Press Inc., 402 Lovett Boulevard, Houston 6, Tex.) 1953. 216 pages, 9 by 6¹/₂ inches, bound. $4.50. A practical book for the television engineer, this text gives complete data and characteristic curves for all Philips' television receiving tubes and for two picture tubes. It also describes typical circuits for each tube; discusses intercarrier sound and flywheel synchronization of the line deflection; and gives a detailed description of a complete television circuit.

ELEKTRISCHE MASCHINEN. Volume II: Synchronmaschinen und Einankerumformer. By Rudolf Richter. Verlag Birkhäuser, Basel, Switzerland, second edition, 1953. 707 pages, 9¹/₄ by 6¹/₂ inches, bound. Sw. Frs. 46.80. This second volume of a comprehensive standard treatise on electrical machines covers synchronous machines and rotary converters. The present volume is a corrected, photomechanical reprint of the 1929 edition, with a supplement consisting of 16 pages of text and some 80 additional literature references.

ENERGY IN THE FUTURE. By Palmer Cosslett Putman. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y., 1953. 556 pages, 9¹/₄ by 6¹/₂ inches, bound. $12.75. A study of the maximum plausible demand for energy on a world scale over the next 50 to 100 years, originally prepared for the Atomic Energy Commission as background for consideration of probable demands for low-cost energy from nuclear fuels. The author reviews rates of population growth, demands for energy, economically recoverable reserves of fuels and such sources of energy as water power, the sun, and others. Estimates of probable demands for energy and of the role of nuclear fuels are made. A bibliography is included.

FASTER THAN THOUGHT. Edited by B. V. Bowden. Sir Isaac Pitman and Sons, Ltd., London, England, (available in U. S. from Pitman Publishing Corporation, 2 West 45th Street, New York 19, N. Y.). 1953. 416 pages, 9 by 6¹/₄ inches, bound. $8.50. A British work on the opportunities which electronic digital computers offer and the difficulties associated with them, including material on computers in America. History and theory, organization, construction, and programming are considered, as is the value of the digital computer to the design engineer, and applications to business, commerce, government, and various types of research.

HOCHFREQUENZMESSTECHNIK. By Friedrich Vilbig. Carl Hanser Verlag, Munich, Germany, 1953. 703 pages, 9¹/₂ by 6³/₄ inches, bound. D.M. 72.00. Assuming a knowledge of the fundamentals of high-frequency engineering, this book presents in detail the basic methods and techniques of high-frequency measurement. It describes not only standard methods using commercial equipment but also rarely used techniques applicable in the solution of new problems. The two major divisions of the book cover respectively general procedures and special applications.

INDUSTRIAL ELECTRONICS. By R. Kretzmann. Philips' Technical Library, Eindhoven, Netherlands (available in U. S. from Elsevier Press, Inc., 402 Lovett Boulevard, Houston 6, Tex.). 1953. 236 pages, 9¹/₄ by 6¹/₄ inches, bound. $5.50. Written primarily for the engineer engaged in supervising or maintaining electronic equipment, this book presents the fundamentals of electronic control. Part I discusses vacuum and gas-filled tubes and their circuits; Part II describes practical electronic devices such as control relays, timers, motor control devices, and many special applications.

TABLES OF NATURAL LOGARITHMS FOR ARGUMENTS BETWEEN ZERO AND FIVE TO SIXTEEN DECIMAL PLACES. (Applied Mathematics Series, Number 31) National Bureau of Standards. Available from Superintendent of Documents, Government Printing Office, Washington 25, D. C., 1953. 501 pages, 10¹/₂ by 8 inches, bound. $3.25. This table of logarithms to the base e covers the indicated range at intervals of 0.0001. As is the case with all volumes in this series an introductory section explains both the methods of calculation and the effective use of the tables.

TABLES OF 10^x. (Applied Mathematics Series, Number 27) National Bureau of Standards. Available from Superintendent of Documents, Government Printing Office, Washington 25, D. C., 1953. 543 pages, 10¹/₂ by 8 inches, bound. $3.50. Antilogarithms to the base 10 are tabulated to ten decimal places from 0 to 1 at intervals of 0.00001; a revision, with corrections, of the Dodson table of 1742.

THE THEORY OF METALS. By A. H. Wilson. Cambridge University Press, 32 East 57th Street, New York 22, N. Y., second edition, 1953. 346 pages, 10¹/₂ by 7¹/₂ inches, bound. $8.50. A systematic, theoretical account of the electronic properties of solids. Basic ideas are introduced in the first two chapters, followed by the application of these ideas to the problems of metallic structures, semiconductors, thermal and magnetic properties of metals, ferromagnetism, and the mechanism of conductivity. In the extensive revision the chapters on superconductivity and optical properties have been deleted.

PAMPHLETS • • • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Industry's Part in Engineering Education. Reprints of the address given by Horace P. Liversidge at the Annual Dinner of the American Society for Engineering Education—Engineers' Council for Professional Development meeting in October 1953 entitled "Industry's Part in Engineering Education" are available on request to Publicity Department, Philadelphia Electric Company, Philadelphia, Pa.

General-Purpose Audio Amplifier. The need for a good general-purpose audio amplifier, for use in microwave testing of all kinds, has long been apparent. This paper outlines the main features that should be incorporated in such an amplifier, including detailed work on automatic normalization. 13 pages. 50¢. Available from Office of Technical Services, U. S. Department of Commerce, Washington, D. C.

Tables of Coefficients for the Numerical Calculation of Laplace Transforms. The tables presented serve to facilitate the numerical evaluation of infinite integrals expressible in the form of Laplace transforms, such as arise in the theory of heat condition and in various branches of electrical engineering. Applications and illustrations of the various uses of the volume are given and a schedule of the explicit expressions of the Lagrange interpolation coefficients is provided. In addition to the tables of the Laplace transforms of the Lagrange coefficients for the 2-point through the 11-point formula, there is also included a short table of $n!/p^{n-1}$. 36 pages. 25¢. Order from the Government Printing Office, Washington 25, D. C.

INDUSTRIAL NOTES . . . .

General Electric News. Appointment of Adam MacKenzie to the position of manager of two of General Electric Lamp Division's factory units, the Cleveland, Ohio, Welds Works and the Jefferson, Ohio, Welds Works has been announced. The appointment of James D. Evans as manager of the division's Carolina Welds Works at Goldsboro, N. C., was announced also. Mr. Evans succeeds Crawford G. Nixon, who retired after 37 years of continuous service with the company.

The silicone products department announced the transfer of its technical service unit from its engineering section to the marketing section, in an organizational move designed to bring custom engineering of silicone products closer to end-user needs. Dr. Charles E. Reed, general manager of the department, concurrently announced that John T. Castles had been appointed manager of technical service unit.

George M. Robertson has been named manager of program planning and research in the company's apparatus advertising and sales promotion department in Schenectady, N. Y. In concurrent announcements, C. Kenneth Emery was appointed to succeed Mr. Robertson in his former assignment as manager of advertising personnel development, and Mr. Emery's previous post as manager of technical publications will be taken by Gilbert E. Smith, Jr.

Two new key appointments in the tube department marketing organization were announced by Grady L. Roark, the department marketing manager. Named to succeed Mr. Roark as manager of equipment tube sales was G. W. DeSousa, formerly manager of tube department marketing administration. Named to succeed Mr. DeSousa as manager of marketing administration was Milton J. Strehle, previously manager of intracompany sales for the tube department. Both men will be located at tube department headquarters at Schenectady.

The appointment of Donald D. Scarff as manager of the Lamp Division's Puget Sound sales district, with headquarters at Seattle, Wash., was announced. Mr. Scarff succeeds L. R. Wilson, who retired December 31, 1953.

RCA Promotions. Promotions and organizational realignments in the Radio Corporation of America (RCA) have been announced. Four RCA vice-presidents were elevated to the position of executive vice-presidents who will be in charge of their respective operations. The organizational changes include the creation of a new Consumer Products Division, a new Electronic Products Division, and a consolidation of staff functions for the entire corporation. Present divisions engaged in other activities of the corporation continue as before. Joseph B. Elliott has been promoted to executive vice-president in charge of the Electronic Products Division. W. Walter Watts has been promoted to executive vice-president in charge of Electronic Products Division. Dr. Elmer W. Engstrom has been promoted to executive vice-president in charge of the RCA Laboratories Division. Charles M. Odorizzi has been promoted to executive vice-president in charge of a newly consolidated corporate staff serving all units and subsidiaries of the RCA.

Dr. Douglas H. Ewing has been named director of a newly formed Physical and Chemical Research Laboratory of the research department, laboratory division.

Appointment of Robert A. Seidel as vice-president of the Sales and Service Subsidiaries Division has been announced.

Westinghouse Notes. Allan Chilton has been appointed chief engineer for the Aviation Gas Turbine Division at South Philadelphia, Pa.

The appointment of Latham E. Osborne, formerly executive vice-president of defense products, as executive vice-president was announced. At the same time, it was reported, that he has been elected to the company's board of directors. Leslie E. Lynde, vice-president in charge of the Aviation Gas Turbine Division at South Philadelphia, Pa., will succeed Mr. Osborne.

J. Chapman Lane, Jr. has been appointed manager of advertising and sales promotion for the Electronic Tube Division.

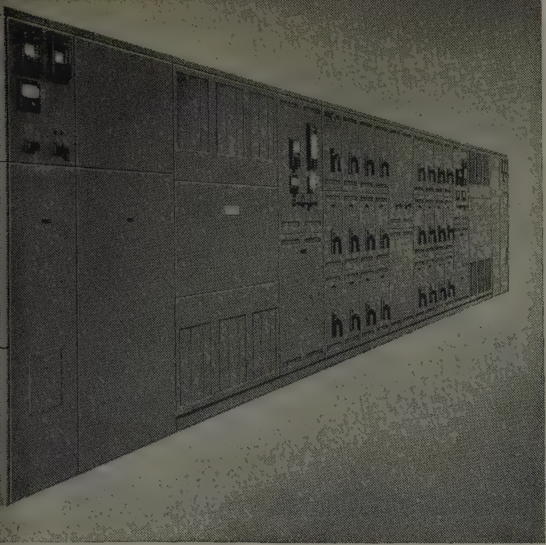
W. Waits Smith has been named manager of the Aviation Gas Turbine Division. In his new post, Mr. Smith will be in charge of all phases of jet aircraft engine development at the Kansas City, Mo., and South Philadelphia plants of Westinghouse.

Allis-Chalmers Appointments. The appointment of Robert L. Carlstein as assistant production control manager at the Allis-Chalmers West Allis Works has been announced. Since February 1949, he had been superintendent of material control. William H. Schrinner has been named successor to Mr. Carlstein.

Three to Executive Posts. Charles B. Sweatt has been elected to the newly created post of vice-chairman of the board of Minneapolis-Honeywell Regulator Company, and two other officers have been elected vice-presidents. The new executive vice-presidents are Tom McDonald and A. M. Wilson. Both formerly had the title of vice-president. In their new posts, they will assist Paul B. Wishart, president, in carrying out managerial duties at the policy-making level.

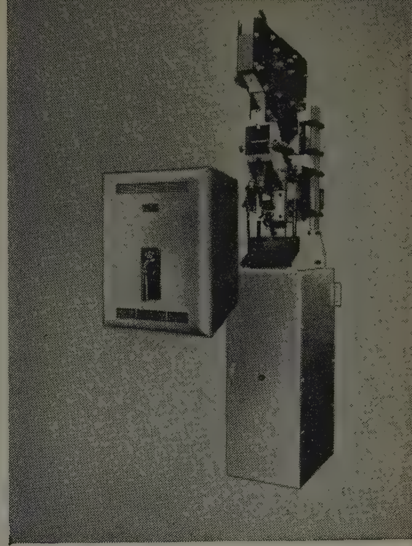
Raytheon Promotion. The appointment of J. Forrest Bigelow as manager of engineering and development for the television and radio division of Raytheon Manufacturing Company has been announced. Mr. Bigelow was formerly in charge of Raytheon's advanced radio and television development department.

(*Continued on page 22A*)



UNIT SUBSTATIONS

LOW-VOLTAGE SWITCHGEAR



LARGE AIR CIRCUIT BREAKER

in your power plans...

for Dependability, Safety, and Over-all Economy

A complete line of Quality Switchgear Equipment

From generation to utilization, I-T-E quality equipment serves every industrial and commercial application. Whether your plans include bus structures, metal-clad or low-voltage switchgear, unit substations, or individual circuit breakers—you are assured of I-T-E's many *extra-service* benefits, which include:

1. selection and application of equipment
2. preparation of specifications
3. coordination of all job requirements

Power is fundamental in any new plant construction or expansion. Power distribution systems must be planned to assure maximum dependability of service, safety for personnel and equipment, and *over-all* economy—from initial planning . . . through the life of the equipment.

Furthermore, it is important to plan power systems with an eye to the future. They should be adaptable to changing plant requirements for many years ahead.

For these reasons, it pays to include I-T-E quality products in your power plans. For over 65 years I-T-E has set the standard for the industry—through engineering skill, design refinement, and introduction of new ideas and thinking.

For details, contact the I-T-E field office nearest you. Look in your classified telephone directory under "Electrical Equipment."

THE SYMBOL OF QUALITY SWITCHGEAR

I-T-E CIRCUIT BREAKER COMPANY

19TH AND HAMILTON STS. • PHILADELPHIA 30, PA.

SWITCHGEAR PRODUCTS

(*Continued from page 18A*)

Leeds and Northrup Changes. Leeds and Northrup Company has announced the promotion of two sales field engineers to district managerships, a change in territory for another manager, and the opening of a new branch office in Milwaukee, Wis. Wilson D. Trueblood, Jr., formerly in the Leeds and Northrup Chicago office, becomes district manager of the new 5-man office at 828 North Broadway, Milwaukee, which will serve all of Wisconsin and Minnesota, the northern peninsula of Michigan, North and South Dakota east of the Missouri River, and the Canadian provinces of Manitoba and western Ontario. Edwin A. Yeo becomes manager at Pittsburgh, Pa. He replaces the late Harold S. Vecella, long-time sales executive there. Willard H. Neu, formerly a sales field engineer in the Pittsburgh office, becomes district manager at Cincinnati, Ohio.

Cannon Appoints New Eastern Engineer. With 20 years' experience in the production and engineering of electric connectors, d-c solenoids, and electrical specialties in Cannon Electric's Los Angeles, Calif., factory, Bruce K. Arnold has been appointed engineer for the eastern division of the company. Eastern headquarters are located at the branch factory in East Haven, Conn. Mr. Arnold will take over the duties previously assigned to Clarke Quackenbush, resigned.

Kaiser Promotion. Jack W. Watson has been appointed director of public relations and advertising by Kaiser Aluminum and Chemical Corporation. He was assistant to the vice-president and general manager prior to his appointment. Mr. Watson will be directly responsible for the company's nation-wide advertising program and also will direct the corporation's public relations activities, including its community relations at its various plant locations throughout the United States. He will make his headquarters at Kaiser Aluminum's home office in Oakland, Calif.

I-T-E Acquires Controlling Interest. The I-T-E Circuit Breaker Company of Philadelphia, Pa., has acquired a controlling interest in The Chase-Shawmut Company of Newburyport, Mass. This acquisition further broadens I-T-E's participation in the electrical distribution field. Chase-Shawmut has manufactured low-voltage fuses for over 60 years, and in recent years has developed a low-voltage, compact, current-limiting fuse. William S. Edsall will continue as president of Chase-Shawmut. P. G. Johnston has been elected vice-president; Laurence B. Cheney, treasurer; and David Greer, secretary.

Shallcross Completes New Plant. A building program completed by the Shallcross Manufacturing Company, Collingdale, Pa., includes completely modernized and larger offices, as well as increased production and engineering facilities.

(*Continued on page 26A*)

(*Continued from page 22A*)

President John S. Shallcross reports a substantial increase in production and much faster deliveries for the 25-year-old concern's line of precision wirewound resistors, rotary selector switches, audio attenuators, and electric-electronic test equipment and assemblies.

Allis-Chalmers to Expand. The Allis-Chalmers Manufacturing Company has announced the completion of plans to enlarge the manufacturing facilities at its Terre Haute, Ind., Works. The building, a 1-story structure, will be 200 by 400 feet with three bays. Facilities will include shop offices and rest and locker rooms. Construction will start immediately under an extension of the present contract with The Austin Company and the addition will be of the same type of construction as the original buildings completed last year. It is hoped that production in the new facilities will get underway by the end of 1954.

NEW PRODUCTS • •

New Device Measures, Plots Two Functions. A new electronic instrument that automatically measures two variable conditions and simultaneously plots their relationship to a third has been developed by the Industrial Division of the Minneapolis-Honeywell Regulator Company in Philadelphia, Pa. Designed essentially as a research tool, the new instrument, known as Electronik Duplex Function Plotter, will be especially useful in a wide range of industrial research activities from missile and engine testing to stress and nuclear engineering analysis, the company reports. In aerodynamic research, for example, the new instrument can plot vibration amplitude and discharge pressure versus speed, or dynamic pressure and yaw angle immersion depth. The instrument incorporates three complete measuring and balancing circuits. While two of these circuits actuate recorder pens horizontally across a specially calibrated chart to record two conditions, the third circuit motivates the instrument chart, up or down, as it measures the third variable. The result is a continuous, automatic plotting, which evaluates the two initial variables in terms of the third one.

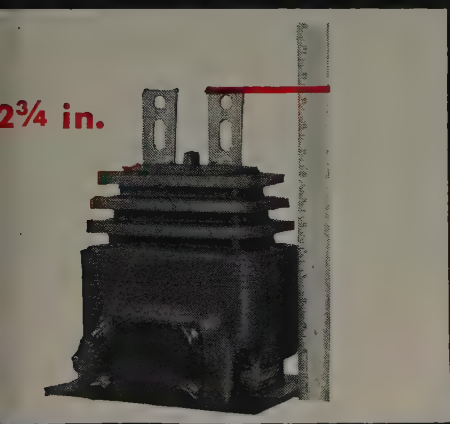
Amplifier for Audio and Ultrasonic Frequencies. The new General Radio's Type *1206-B* unit amplifier has a maximum output of 3 watts which is adequate for driving many low-power transducers. Since less than 1 volt input is required for full output, the amplifier can operate directly from the output of many electroacoustic and electromechanical devices, such as sound-level and vibration meters, to amplify their outputs for such purposes

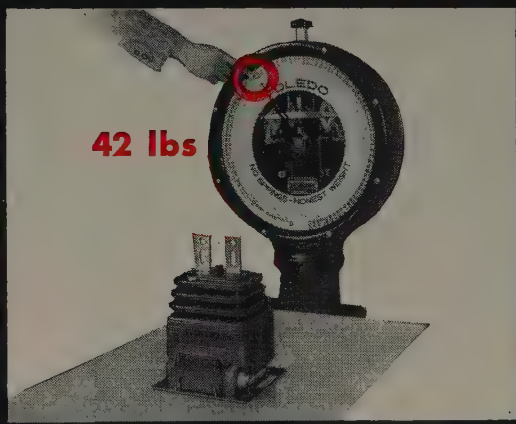
(*Continued on page 36A*)

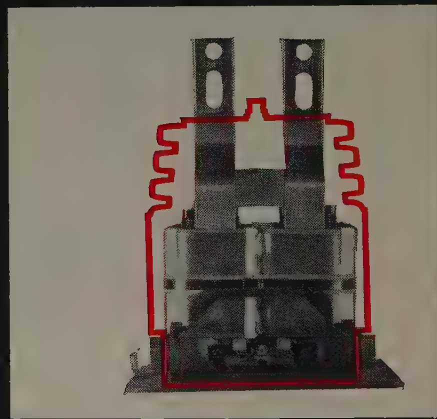
GENERAL ELECTRIC ANNOUNCES

A 5000-volt butyl-molded current transformer for outdoor applications

NEW TYPE JKW-3 OFFERS SIX MAJOR FEATURES



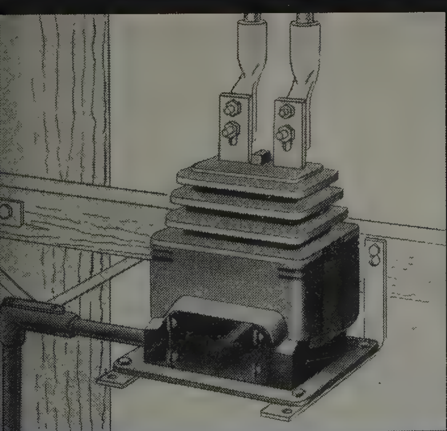


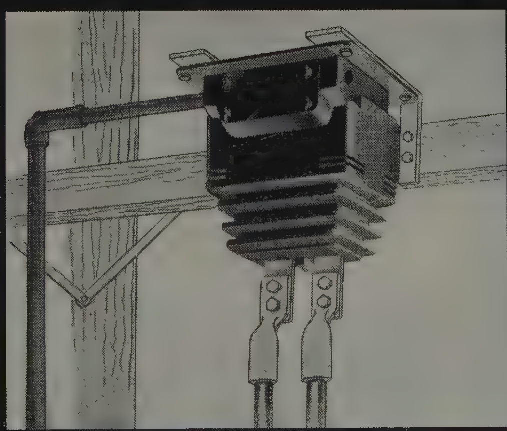


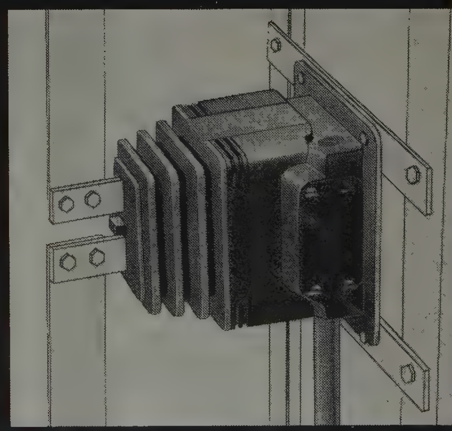
2 **ONE THIRD SMALLER** in all ratings than other top-connected 5 KV designs, the new General Electric JKW-3 transformer is easier to install.

3 **LIGHT WEIGHT** of current transformer, only 42 pounds, facilitates handling and installation. Weighs 1/3 less than other top-connected 5 KV outdoor designs.

4 **UNIFIED CONSTRUCTION OF JKW-3** assures high mechanical strength. Butyl serves as insulation, case, and bushing.







6 **VERSATILE MOUNTING,** the new General Electric JKW-3 transformer is applicable to bottom-, top- or side-connected installations. It can be platform-mounted, bolted directly to a crossarm, or attached by U-bolts or suspension hooks. This versatility of positioning and mounting reduces installation cost. Two L-shaped brackets are supplied with each transformer. Auxiliary L-brackets for U-bolt mounting and suspension hooks are available upon request.

FOR MORE INFORMATION on the new G-E 5000-volt outdoor current transformer, contact your nearest G-E representative, or write for Bulletin GEC-1222 to Section 604-39, General Electric, Schenectady 5, N. Y.

GENERAL ELECTRIC

(*Continued from page 26A*)

as operating graphic recorders. The wide frequency range of the Type *1206-B* extends from below 10 cycles up to about 250 kc, so that both low-frequency and high-frequency signals can be handled. The outputs of such sources as the Type *1390-A* random-noise generator and other low-power generators and oscillators can also be amplified by the Type *1206-B*. The Type *1206-B* is one of General Radio's Unit line of instruments and is designed to operate from the Type *1203-A* Unit Power Supply which can be attached to the amplifier to form a single, rigid assembly.

Microglaze Suspension Insulator. A new development, the microglaze suspension insulator, has been announced by the Locke Department of the General Electric Company. It is stated that the development of the Microglaze suspension insulator is perhaps the most important new refinement in manufacturing technique the industry has seen since Locke introduced compression glaze in 1935. Insulator's ability to resist mechanical impact varies with glaze thickness. Too much glaze, or too little, will not develop all the potential strength which glaze can give to porcelain. On Microglaze insulators, glaze thickness is held within what Locke research has proved to be a range of peak strength, where resistance to mechanical impact is greatest.

Sealed Resistors Announced. Lightweight encapsulated precision wire-wound resistors in 11 new styles have been announced by the Shallcross Manufacturing Company, Collingdale, Pa. Shallcross *P* type encapsulated resistors are currently available in all lug-type *MIL-R 93A* styles as well as in five axial lead types including several that conform to *MIL-R-93A*, style *RB52*. Commercial wattage ratings range to 3.5 watts at 125 C operation. Bulletin *L-30* giving test data, available styles, and ratings for Shallcross *P* type resistors is available on letterhead request to the manufacturer.

Thermal Unit. A new quick-trip overload thermal unit for protecting hermetically sealed compressor motors, has been announced by the Square D Company. Type *FB* quick-trip unit trips in approximately one-third the time required by the Type *B* standard unit. In addition to short trip time and dependable repeat protection, an important feature is interchangeability. The thermal element used is a separate factory calibrated unit and is not an integral part of the overload relay block. For complete details, write to the Square D Company, 4141 North Richards Street, Milwaukee 12, Wis.

Resistors. Dale Products, Inc., of Columbus, Neb., which previously has concentrated on the manufacture of deposited carbon resistors to meet *MIL-R-10509A* specifications, have just introduced their new commercial grade de-

(*Continued on page 46A*)


Continuous glazing machines like this give Victor insulators an even coat of uniform thickness.


VICTOR NO. 900 SUSPENSION INSULATOR

(*Continued from page 36A*)

posited carbon stable resistors in tolerances of 1, 2, 5, and 10 per cent. Standard resistance ranges in the 1/2-watt size are from 1 ohm through 5 megohms; in the 1-watt size from 1 ohm through 10 megohms; in the 2-watt size, 5 ohms through 100 megohms. Further information may be obtained by writing to the manufacturer.

Compact Plier-Type Hytool. Three new lightweight Hytools Type *Y-MR* have been developed by the Burndy Engineering Company, Inc., for the installation of insulated terminals and terminal block contact tips. A plier-type tool, the *Y-MR* Hytool has a positive-action ratchet control that assures proper depth of indent and a spring return that reopens the jaws when the installation is completed. One variation of the Hytool is designed to install insulated terminals that take copper aircraft wire sizes *AN-26* through *AN-20;* and another variation installs terminal block contact tips on wire sizes *AN-20* through *AN-12.* Write to Burndy Engineering Company, Norwalk, Conn., for further information.

Power Resistors. Two new high-temperature resistors, types *PW-7* and *PW-10,* have been introduced by the International Resistance Company, Philadelphia, Pa. Unique in their rectangular shape, these units have been designed to allow a high degree of automatic assembly at a low cost. Wire elements are uniformly and tightly wound on glass fibre cores with axial leads $1^1/_2$ inches long; 0.36 inch diameter. These power resistors are particularly recommended for circuits requiring an actual wattage dissipation of 7 or 10 watts or less, resistance elements of resistance capacitance filter in automobile receiving sets when the operation is at high ambient temperatures, and all other circuits requiring a stable low-cost easily installed unit. For further information, write International Resistance Company, 401 North Broad Street, Philadelphia 8, Pa.

Magnetic Relay. A new compact magnetic relay designed for use with single-phase capacitor start motors requiring a voltage-sensitive relay to disconnect the start winding or reduce the capacitance when the motor approaches full speed, has been announced by the Square D Company. Double break, silver-to-silver contacts on the single-pole normally closed relay are capable of handling start winding currents up to 50 amperes on 115-volt motors and 35 amperes on 230-volt motors. Magnet coils are available for continuous duty ratings up to 480 volts, 60 cycles, or 300 volts, 25 cycles. Relay pull-in voltage is adjusted at the factory for operation within the desired range. For further information write to the Square D Company, 4141 North Richards Street, Milwaukee, Wis., and ask for Bulletin *Class 8505 Type C.*

(*Continued on page 50A*)

(*Continued from page 46A*)

Small Camera Tube. A small camera tube of the vidicon type intended primarily for use in television cameras for motion-picture film, transparencies, and opaques has been announced by the RCA Tube Department. The small size and simplicity of this new vidicon, designated as RCA-*6326*, facilitate the design of the camera and associate equipment in comparison with iconoscope cameras. Utilizing a photoconductive layer as its light-sensitive element, the *6326* has a sensitivity which permits televising motion-picture film with $^1/_3$ to $^1/_2$ of the light requirements of the iconoscope. For televising transparencies and opaques, the light requirement is only $^1/_{20}$ of that needed for film pickup. The photoconductive layer has a spectral-response characteristic approaching that of the eye.

Dustproof Motor. The Crocker-Wheeler Division of Elliott Company has announced a new taconite-dustproof motor. A special modification of its *CFC* Sealedpower totally enclosed fan-cooled motor, it is of particular use in ore-refining plants using the taconite benificiation process where crushing, mixing, and drying operations produce an atmosphere burdened with fine magnetic dust. Features which make this possible are nonferrous slingers and bushings, a heavy fibrous grease seal, prelubricated and sealed ball bearings, and a long, close-tolerance fit between bearing brackets and frame. Leads are sealed in with an air-hardening plastic, and the motor is self-cleaning with its fan-driven cooling air directed along the heat radiating fins and no outer casing under which dust can collect.

TRADE LITERATURE

Heating Catalogue. A 1954 edition of General Electric's catalogue on Calrod electric heaters and heating devices has been announced as available from the company at Schenectady 5, N. Y. Designated as *GEC-1005E*, the 60-page 2-color catalogue describes the units in terms of application, special features, installation, and pricing. Indexed by processes and application, the catalogue contains methods for determining power requirements and heat losses for many applications. Another feature of the publication is an index of industrial heating applications bulletins, and data and specification sheets available.

Modern Electrical Living Booklet. The Arrow-Hart and Hegeman Electric Company of Hartford, Conn., announces the availability of a new 40-page booklet which is offered for 10 cents. It is designed to help the homeowner who is building or remodeling, to plan a home complete with

(*Continued on page 56A*)

GENERAL ELECTRIC ANNOUNCES...

Revolutionary New Molecular Vacuum Gage

SIMPLIFIED VACUUM MEASUREMENT • EASY OPERATION • EASY INSTALLATION

Similar to a "fluid clutch" in principle of operation, this new entirely mechanical molecular vacuum gage overcomes many of the problems encountered in the use of other type vacuum gages.

NO PRIMARY ELEMENT TO BURN OUT

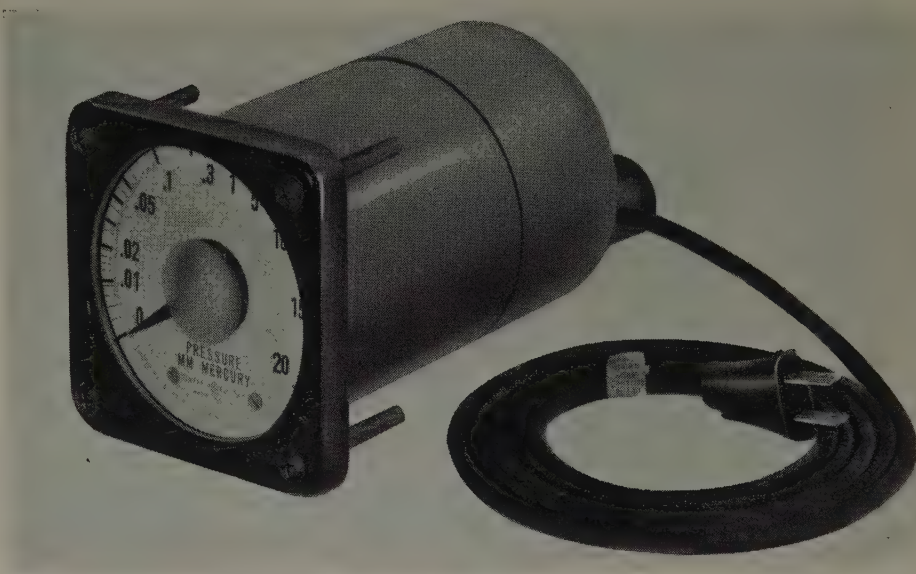
Having no electronic tubes or other electrical detecting devices, the new General Electric molecular vacuum gage assures continuous operation without time-consuming delays caused by electrical failure such as tube burnout.

UNHARMED BY ATMOSPHERIC PRESSURE

Because this new device may be opened to atmospheric pressure suddenly, without damage to the instrument, it is especially valuable where personnel may be untrained in the use of complicated instruments.

FURTHER INFORMATION

Price is $195.00.* For further details, check coupon for Bulletin GEC-986.



EASY-TO-OPERATE, the molecular vacuum gage requires no complicated setting of control knobs. Direct-reading, the instrument calibration remains unaltered through continuous operation. The long scale span in the high-vacuum range, and the highly legible numerals of the indicator dial assure accurate readings. Face-plate studs facilitate panel mounting.

THERMOCOUPLE VACUUM GAGE

VACUUM MEASUREMENT with this instrument eliminates need for permanent test panels, lowers investment costs. Gage provides continuous indication, fast response. Price is $117.59.*

THERMOCOUPLE POTENTIOMETER

ACCURATE THERMOCOUPLE TEMPERATURES are quickly and easily determined with this portable instrument. Valuable when making temperature surveys, this self-contained potentiometer is priced at $198.90.*

SECTION C605-73
GENERAL ELECTRIC COMPANY
SCHENECTADY 5, N. Y.

Please send me the following bulletins:

- ☐ Molecular Vacuum Gage (GEC-986)
- ☐ Portable Double Bridge (GEC-251)
- ☐ Insulation-resistance Meter (GEC-753)
- ☐ Thermocouple Vacuum Gage (GEC-385)
- ☐ Thermocouple Potentiometer (GEC-245)

Name..

Company..

Street..

City.......................Zone....State..............

GENERAL ELECTRIC

(*Continued from page 50A*)

every electrical convenience. Featured in this booklet, "Easier Living Within Your Power Electrically," is a handy check list that makes it a simple matter for the home-owner to determine just what he needs in switches, receptacles, convenience outlets, etc. Large quantities, for distribution to customers and prospects, may be obtained, with free imprinting, at reduced rates. For ordering information, write to The Arrow-Hart and Hegeman Electric Company, 103 Hawthorn Street, Hartford, Conn.

Teflon. A third revision of the Du Pont technical bulletion on Teflon tetrafluoroethylene resin finishes is now available. The 12-page bulletin lists 17 successful new Teflon applications in addition to those reported in the earlier edition published in March 1953. All new uses are derived from the notable release or antisticking property of Teflon, its high corrosion and heat resistance, as well as its low coefficient of friction. The booklet discusses various finishing systems of Teflon primers and enamels over metallic and nonmetallic surfaces, application methods, the fusing operation, precautions, and handling procedures. The bulletin may be obtained by writing Du Pont Finishes Division, Room D-7145, Wilmington 98, Del.

Distribution Regulators. A 12-page bulletin describing the external and internal features of Allis-Chalmers distribution regulators, Type *JFR*, has been released by the company. The design and construction details of the latest "Quick-Break" tap-changing mechanism, improved "Feather-Touch" control, and unit construction are pictorially displayed and discussed. Listed in the bulletin are the standard accessories and specifications for the Type *JFR* distribution regulator which is available in ratings of 2,500 volts, 100 and 200 amperes; 5,000 volts, 50 and 100 amperes; 7,620 volts, 15, 50, and 100 amperes; and 14,400 volts, 50 and 100 amperes. Copies of the bulletin, "Allis-Chalmers Distribution Regulators," *21B7977*, are available on request from the Allis-Chalmers Manufacturing Company, 70th Street, Milwaukee, Wis.

Packaging Information. New and improved packaging for everything from acids and artichokes to tap drills and toiletries, is described in a booklet published by the Bakelite Company. This "1954 Guide to Improved Packaging With Bakelite Plastics and Resins," contains detailed information on the latest applications of molded and blown plastics, coatings, adhesives, film and rigid sheet materials for both packaging and display. The booklet presents the wide range of properties of Bakelite polyethylene, phenolic, styrene, C-11, and vinyl plastics and resins which have made them extremely versatile as containers and dispensers for all kinds of products. Illustrated with 48 photographs of actual packaging applications, the booklet also describes briefly the major properties, advantages, color, and finish possibilities of each material. Copies of this booklet, *G-21*,

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can be obtained by writing to the Bakelite Company, a Division of Union Carbide and Carbon Corporation, 300 Madison Avenue, New York 17, N. Y.

Movie on Atmospheric Gases. A new 16-millimeter color motion picture with sound entitled, "Whatever We Do," has been produced by Air Reduction. It is a basic documentary film about the atmospheric gases; oxygen, nitrogen, argon, helium, and the other rare gases, covering their key uses in industry, and the countless ways they appear in our daily lives as parts of familiar products. It was produced to explain in an easy-to-understand fashion, the manufacturing process and distribution system involved in the marketing of atmospheric gases. Running time is 23 minutes. The film may be borrowed from any Air Reduction district office or by getting in touch with Air Reduction Sales Company, 60 East 42d Street, New York 17, N. Y.

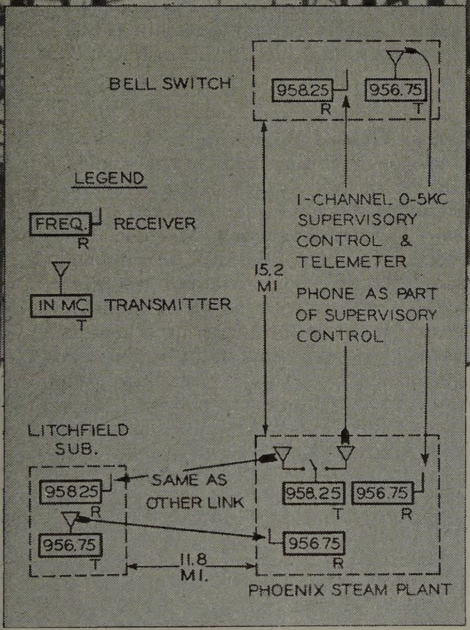
Heat Pump. A 4-page bulletin available from the Westinghouse Electric Corporation describes their new all-electric heat pump. The heat pump is the completely self-contained system that, without water or flame, provides warm filtered air in the winter, and cool dehumidified air in the summer. A complete explanation of the heating and cooling cycles of the unit is presented, including schematic flow diagrams of the refrigerant and air. Each of the new features of the heat pump is described such as the elimination of flame-type fuels, water connections, and the usual seasonal adjustments and maintenance. Use of existing ductwork is discussed as well as possible locations in the home of either the 3- or 5-hp unit. For a copy of this heat pump bulletin, write Westinghouse Air Conditioning Division, Department T-557, 200 Readville Street, Hyde Park, Boston 36, Mass.

Magnetic Contactors. Federal Electric Products Company, 50 Paris Street, Newark 5, N. J., has issued a new booklet, Bulletin *502*, describing Federal Noark magnetic contactors. The bulletin gives complete information on Federal's magnetic contactors including dimensions and weights. Bulletin *502* magnetic contactors are designed to provide a safe, dependable means for repeated quick closing and opening of electric circuits controlling the sequence of operations in modern multiple action machines. They are electric switches in which the make and break action is controlled by an electromagnet and are used for resistance loads as well as a wide variety of electric motor loads where overload protection is not required or is otherwise provided for.

Rotomotive Equipment for Aircraft. Jack and Heintz, Inc., has announced the publication of a new bulletin number *6014*, which describes the company's rotomotive equipment for aircraft. Comprehensive tabulations present design, performance,

(*Continued on page 64A*)

Microwave provides all-weather remote control and telemetering for Arizona Public Service Co
Unattended substations receive control impulses from steam plant at Phoeni



Arizona Public Service Co. 960-mc Microwave system. Selector switch connects transmitter to either antenna at Phoenix steam plant

Through severest heat, sand, electric storms . . . Arizona Public Service Company's remote supervisory control system (via Microwave) stays on the job

Since 1949 Arizona Public Service Company has used RCA Microwave for remote supervisory control of two substations from a steam-electric plant. One installation provides remote control and indications on five 69-kv breakers, telemetering of voltage and current, and a 2-way voice channel. The other installation controls two breakers and provides telemetering and voice channels between plant and switching station. (*See schematic.*)

Four years of operation under trying conditions have proved the reliability of RCA Microwave. Through ambient 140-degree heat, high winds, severe sand and dust storms, violent rain and electric storms—Public Service's supervisory control system stayed on the job. Here was a link which was independent of the transmission lines it services . . . providing reliable communications and control when needed most.

MANY ENGINEERING ADVANTAGES

Sound engineering features led Public Service to select microwave rather than high-line carrier. Microwave offered good noise and distortion characteristics, easy tie-in with mobile radio, greater channel capacity, reasonable freedom from interference, and relative ease of maintenance.

The economy factor also favored RCA Microwave. While a one-channel microwave system generally costs more than carrier to install, *in this particular case* it cost $9,000 less because crowded carrier frequency space would require considerable new equipment. In addition, RCA Microwave's built-in provisions for extra channels make it the *least expensive form of communication per channel mile.*

A PRACTICAL SYSTEM

Outage time of RCA Microwave is next to zero. "Dish" antennas beam highly directional radio signals from one relay station to the next. The radio transmissions follow a line-of-sight path—can approximately parallel power lines. Equipment uses easy-to service familiar circuits and readily availabl tubes. It can interconnect with existing tele phone lines, switchboards and mobile radi installations. One RCA Microwave syste will handle up to 25 voice channels (or 2 x 18 telemetering and control channels).

You can prepare now for your expandin communications needs, *before they develop* The booklets listed below provide quickl digested facts to help with future planning *Mail the coupon—there's no obligation on you part.* And remember, the RCA Service Com pany provides nation-wide installation an service facilities.

RADIO CORPORATION of AMERICA
COMMUNICATIONS EQUIPMENT CAMDEN, N. J.

Dept.C42, Building 15-1

Without obligation on my part, please send me
your *free* booklet on: ☐ Microwave for Telemetering and Supervisory Control
☐ Electric Utility Microwave Systems

Name__________ Title__________

Company__________ Address__________

City__________ Zone_____ State__________

☐ Have an RCA communications specialist get in touch with me

(Continued from page 62A)

and application data on turbojet engine starters, reciprocating engine starters, a-c and d-c generators, motors, actuators, and completely integrated electric control systems. Bulletin number *6014* is available on request to Jack and Heintz, Inc., 17600 Broadway, Cleveland 1, Ohio.

Power-Line Carrier Booklet. The complete line of Westinghouse power-line carrier equipment, Type *FD*, is described in a 12-page booklet available from Westinghouse Electric Corporation. Some features of Type *FD* equipment described are improved receiver selectivity, operation from station batteries, filament current regulation, and accessibility of assemblies. Use of carrier for relaying, telemetering, supervisory control, and voice communications is discussed. For a copy of booklet *B-5873*, write Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

Tracer Guided Engravings. A 24-page catalogue describing the industrial application of various models of tracer guided engraving machines manufactured by the New Hermes Engraving Machine Corporation has been released. The publication pictures and describes machines adaptable to a wide scope of industrial needs. It covers the engraving of plastics, metal, glass, and wood, and also illustrates methods of calibrating, profiling, and slotting. Copies of the catalogue, "Tracer Guided Engravings," are obtainable from New Hermes Engraving Machine Corporation, 13–19 University Place, New York 3, N. Y.

Instrument Transformer Buyer's Guide. The 1954 edition of the G-E Instrument Transformer Buyer's Guide, containing basic, up-to-date information on the complete General Electric line, has been announced as available from the company at Schenectady 5, N. Y. The fully illustrated, 96-page publication, *GEA-4626G*, contains ratings, American Standards Association accuracy classifications, and prices of all G-E indoor and outdoor potential and current transformers. Listings of ratio and phase-angle test, together with tables covering the mechanical and thermal limits of current transformers, are included.

Audio Devices Offers Two Booklets. Two publications distributed without charge are offered by Audio Devices, Inc., 444 Madison Avenue, New York 22, N. Y. One of these is a selection of articles by educational people entitled, "The Teacher Talks About Sound Recording." This 40-page illustrated booklet presents some ideas to stimulate a consciousness of the tremendous learning potential that the tape recorder has to offer. The latter brochure, "Fundamentals of Magnetic Recording," should interest many engineers as it gives a brief statement on what makes magnetic recording work. This 46-page booklet includes a history of magnetic recording, tape versus wire, magnetic recording method, erasing, tape construction, and hints on selecting a tape recorder.